

**CHAMAN LAL MAHAVIDHYALYA, LANDHAURA,
MANGLOAR ROAD, HARIDWAR (AUTONOMOUS)**

AFFILIATED

**SRI DEV SUMAN UTTARAKHAND UNIVERSITY, BADSHAHITHAUL
TEHRI GARHWAL, UTTARAKHAND**



NATIONAL EDUCATION POLICY-2020

STRUCTURE OF

UG / PG - SYLLABUS

2026-2027

National Education Policy (NEP)-2020

**Common Minimum Syllabus for College
Four Year Undergraduate Programme-FYUP/Honours
Programme / Master in Science**

**PROPOSED STRUCTURE FOR
FYUP/MASTER'S BOTANY SYLLABUS**

DEPARTMENT OF BOTANY

**CHAMAN LAL MAHAVIDHYALYA, LANDHAURA,
MANGLOAR ROAD, HARIDWAR (AUTONOMOUS)**

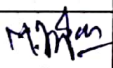
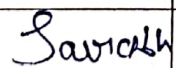
AFFILIATED

**SRI DEV SUMAN UTTARAKHAND UNIVERSITY, BADSHAHITHAUL
TEHRI GARHWAL, UTTARAKHAND**

List of Members of Board of Studies

Department of Botany

(Session 2026-27)

S. No.	Name of the Members	Designation	Nominated as
1.	Dr. Mohd. Irfan 	Assistant Professor & Head	Chairman
2.	Dr. Richa Chauhan 	Assistant Professor	Member
3.	Dr. Subhash Kumar	Assistant Professor & Head	Nominated Expert
4.	Dr. Rachana Tyagi	Assistant Professor	Nominated Expert
5.	Dr. Vipin Kumar 	Assistant Professor & Head	Nominated Expert selected by Principal
6.	Mr. Saurabh 	Student	Ex-student

List of Papers (DSC, DSE, GE) with Semester Wise Titles for 'Botany'					
(DSC-Discipline Specific Course; DSE-Discipline Specific Elective; GE-Generic Elective)					
Year	Semester	Course	Paper Title	Theory/ Practical	Credits
Undergraduate Certificate in Botany					
FIRST YEAR	I	BOTDSC1	Plant Diversity I (Microbes, Fungi and Algae)	Theory	3
		BOTDSC1P	Practical/LabCourseBOTDSC1P	Practical	1
		BOTGE1	Plant Cell Biology	Theory	4
	II	BOTDSC2	Plant Diversity II (Bryophyta, Pteridophyta and Gymnosperm)	Theory	3
		BOTDSC 2P	Practical/LabCourse BOTDSC2P	Practical	1
		BOTGE2	Plant Science– I	Theory	4
Undergraduate Diploma in Botany					
SECOND YEAR	III	BOTDSC3	Plant Systematics and Developmental Biology (Taxonomy, Embryology and Anatomy)	Theory	3
		BOTDSC3P	Practical/LabCourseBOTDSC3P	Practical	1
		BOTDSE1	Plant Tissue Culture	Theory	4
		BOTGE3	Plant Science– II	Theory	4
	IV	BOTDSC4	Cytology, Genetics and Biotechnology	Theory	3
		BOTDSC4P	Practical/LabCourseBOTDSC4P	Practical	1
		BOTDSE2	Ethnobotany	Theory	4
		BOTGE4	Inheritance in Plant Biology	Theory	4

Bachelor in Botany					
THIRD YEAR	V	BOTDSC5	Plant Physiology and Biochemistry	Theory	3
		BOTDSC5P	Practical/Lab Course BOTDSC5P	Practical	1
		BOTDSE3	Conservation and Management of Natural Resources	Theory	4
		BOTGE5	Medicinal Plants of Uttarakhand	Theory	4
		BOTIAPC	Internship/Apprenticeship/Project/Community Outreach	Theory/ Practical	2
	VI	BOTDSC6	Plant Ecology and Biostatistics	Theory	3
		BOTDSC6P	Practical/Lab Course BOTDSC6P	Practical	1
		BOTDSE4	Fundamentals of Molecular Biology	Theory	4
		BOTGE6	Global Climate Change	Theory	4
		BOTIAPC	Internship/Apprenticeship/Project/Community Outreach	Theory/ Practical	2

Bachelor in Botany with Honours					
FOURTH YEAR	VII	BOTDSC7	Cryptogams	Theory	3
		BOTDSC7P	Practical/Lab Course BOTDSC7P	Practical	1
		BOTDSE5	Plant Biotechnology	Theory	4
		BOTDSE6	Microbiology	Theory	4
		BOTDSE7	Plant Development and Reproductive Biology	Theory	4
		BOTGE7	Molecular Biology	Theory	4
		BOTGE8	Fundamentals of Biochemistry	Theory	4

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	VIII		Dissertation/Academic Project/ Entrepreneurship	Theory/ Practical	6
		BOTDSC8	Phanerogams	Theory	3
		BOTDSC8P	Practical/LabCourseBOTDSC8P	Practical	1
		BOTDSE8	Cytogenetics	Theory	4
		BOTDSE9	Ecology	Theory	4
		BOTDSE10	Plant System Physiology	Theory	4
		BOTGE9	Methods in Plant Biology and their applications	Theory	4
		BOTGE10	Traditional Knowledge System	Theory	4
			Dissertation/Academic Project/ Entrepreneurship	Theory/ Practical	6

Master's in Botany					
FIFTH YEAR	IX	BOTDSC9	Plant Resource Utilization and Conservation	Theory	3
		BOTDSC9P	Practical/LabCourseBOTDSC9P	Practical	1
		BOTDSE11	Evolutionary Biology of Plants	Theory	4
		BOTDSE12	Plant Pathology	Theory	4
		BOTDSE13	Protected Agriculture: Hydroponics and Organic Cultivation	Theory	4
		BOTGE11	Forest Ecology	Theory	4
		BOTGE12	Herbarium Techniques	Theory	4
			Dissertation/Academic Project/ Entrepreneurship	Theory/ Practical	6
	X	BOTDSC10	Environmental Monitoring and	Theory	3

			Ecological Restoration		
		BOTDSC10P	Practical/LabCourseBOTDSC10P	Practical	1
		BOTDSE14	Bioinformatics and Bio-safety norms	Theory	4
		BOTDSE15	Advances in Plant Taxonomy	Theory	4
		BOTDSE16	Plant Breeding	Theory	4
		BOTGE13	Lichenology	Theory	4
		BOTGE14	Palaeobotany	Theory	4
			Dissertation/Academic Project/ Entrepreneurship	Theory/ Practical	6

List of Skill Enhancement Courses Papers (SEC) with Semester Wise Titles for ‘Botany’					
Year	Semester	Course	Paper Title	Theory/ Practical	Credits
Undergraduate Certificate in Botany					
FIRSTYEAR	I	BOTSEC-MC-1	Mushroom Cultivation-I	Theory	1
		BOTSEC-MC-1P	Practical/LabCourseBOTSEC-MC-1P	Practical	1
	II	BOTSEC-MC-2	Mushroom Cultivation-II	Theory	1
		BOTSEC-MC-2P	Practical/LabCourseBOTSEC-MC-2P	Practical	1
Undergraduate Diploma in Botany					
SECOND YEAR	III	BOTSEC-MC-3	Mushroom Cultivation-III	Theory	1
		BOTSEC-MC-3P	Practical/LabCourseBOTSEC-MC-3P	Practical	1
	IV	BOTSEC-MC-4	Mushroom Cultivation-IV	Theory	1
		BOTSEC-MC-4P	Practical/LabCourseBOTSEC-MC-4P	Practical	1

Bachelor in Botany					
THIRDYEAR	V	BOTSEC-MC-5	Mushroom Cultivation-V	Theory	1
		BOTSEC-MC-5P	Practical/LabCourseBOTSEC-MC-5P	Practical	1
	VI	BOTSEC-MC-6	Mushroom Cultivation-VI	Theory	1
		BOTSEC-MC-6P	Practical/LabCourseBOTSEC-MC-6P	Practical	1

List of Skill Enhancement Courses Papers (SEC) with Semester Wise Titles for 'Botany'					
Year	Semester	Course	Paper Title	Theory/ Practical	Credits
Undergraduate Certificate in Botany					
FIRSTYEAR	I	BOTSEC-H-1	Hydroponics-I	Theory	1
		BOTSEC-H-1P	Practical/LabCourseBOTSEC-H-1P	Practical	1
	II	BOTSEC-H-2	Hydroponics-II	Theory	1
		BOTSEC-H-2P	Practical/LabCourseBOTSEC-H-2P	Practical	1
Undergraduate Diploma in Botany					
SECOND YEAR	III	BOTSEC-H-3	Hydroponics-III	Theory	1
		BOTSEC-H-3P	Practical/LabCourseBOTSEC-H-3P	Practical	1
	IV	BOTSEC-H-4	Hydroponics-IV	Theory	1
		BOTSEC-H-4P	Practical/LabCourseBOTSEC-H-4P	Practical	1
Bachelor in Botany					
THIRDYEAR	V	BOTSEC-H-5	Hydroponics-V	Theory	1
		BOTSEC-H-5P	Practical/LabCourseBOTSEC-H-5P	Practical	1
	VI	BOTSEC-H-6	Hydroponics-VI	Theory	1
		BOTSEC-H-6P	Practical/LabCourseBOTSEC-H-6P	Practical	1

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List of Skill Enhancement Courses Papers (SEC) with Semester Wise Titles for ‘Botany’					
Year	Semester	Course	Paper Title	Theory/ Practical	Credits
Undergraduate Certificate in Botany					
FIRSTYEAR	I	BOTSEC-NF-1	Nursery Development and Floriculture-I	Theory	1
		BOTSEC-NF-1P	Practical/LabCourseBOTSEC-NF-1P	Practical	1
	II	BOTSEC-NF-2	Nursery Development and Floriculture-II	Theory	1
		BOTSEC-NF-2P	Practical/LabCourseBOTSEC-NF-2P	Practical	1
Undergraduate Diploma in Botany					
SECOND YEAR	III	BOTSEC-NF-3	Nursery Development and Floriculture-III	Theory	1
		BOTSEC-NF-3P	Practical/LabCourseBOTSEC-NF-3P	Practical	1
	IV	BOTSEC-NF-4	Nursery Development and Floriculture-IV	Theory	1
		BOTSEC-NF-4P	Practical/LabCourseBOTSEC-NF-4P	Practical	1
Bachelor in Botany					
THIRDYEAR	V	BOTSEC-NF-5	Nursery Development and Floriculture-V	Theory	1
		BOTSEC-NF-5P	Practical/LabCourseBOTSEC-NF-5P	Practical	1
	VI	BOTSEC-NF-6	Nursery Development and Floriculture-VI	Theory	1
		BOTSEC-NF-6P	Practical/LabCourseBOTSEC-NF-6P	Practical	1

COURSE INTRODUCTION

The new curriculum of Botany offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core, elective and vocational papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently being used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts in laboratory sessions. Fieldwork, outstation activities, and projects will also be organized to provide real-life experiences and learning opportunities. Candidates with a curiosity about the plant kingdom and ecosystems, a passion for exploring exotic places, and a desire to work as researchers or in professions such as Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

The M.Sc. - Botany programme is designed to equip students with essential knowledge and technical skills of plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core and elective papers with significant inter-disciplinary components. Students would be exposed to progressive technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

Programme outcomes (POs):

Transformed curriculum shall develop educated outcome-oriented candidates, fostered with discovery-based learning, equipped with practice & skills to deal practical problems and versed in recent pedagogical trends in education including e-learning, flipped classrooms and hybrid learning. This approach prepares them to become responsible citizens, contributing to nation-building and driving the country forward with the knowledge they gain in the field of plant science.

Programme specific objectives (PSOs): B.Sc. I Year Certificate Course in Botany

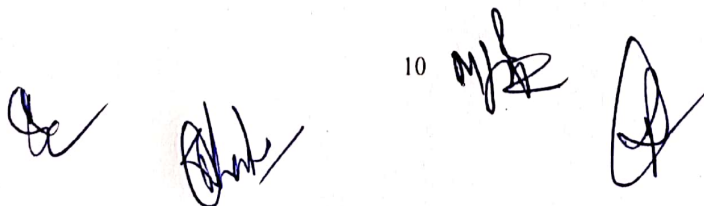
- This certificate course will provide knowledge in various fields of basic Botany.
- The syllabus is designed to prepare students for competitive exams in frontier areas of plant sciences.
- Students will be able to understand habit, habitat, morphology, anatomy and reproduction of various plant groups.

Programme specific outcomes (PSOs): B.Sc. II Year/ Diploma Course in Botany

- This programme will provide knowledge of plant morphogenesis, anatomy embryology and plant genetics.
- Laboratory sessions following theory will facilitate easy understanding of internal structure of various plant parts, structural organization, reproductive biology and genetics.
- This course will equip students to pursue a career as plant morphologists.

Programme specific outcomes (PSOs): B.Sc. III Year/Bachelor of Science

- The three year learning outcome of graduation will provide understanding of Plant Systematics, Economic Botany, Developmental Biology, Ecology, Biostatistics, Physiology, and Biochemistry.
- It will provide expertise in conservation biology and reproduction biology.
- Upon successful completion of this course, students will be able to contribute to the field of plant sciences. The research project will help cultivate a research aptitude for higher education and scientific research.



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Programme specific outcomes (PSOs): M.Sc. I Year/ Bachelor of Botany with Honours

- The four year learning programme will provide knowledge on different aspects of Botany such as Microbiology, Phycology, Mycology, Lichenology and Bryology.
- The student completing the course will gain an understanding of the diversity and evolutionary biology of plants, concepts and processes in Plant Anatomy, Developmental Biology, Plant Breeding, Plant biotechnology and Fundamentals of Biochemistry.
- The course will also help students understand the Traditional Knowledge System.

Programme specific outcomes (PSOs): M.Sc. II Year/Masters in Botany

- The student completing the course will understand the diversity and phylogeny of the Pteridophytes, Gymnosperms and Taxonomy of Angiosperms.
- This programme will provide knowledge on various life forms of plants, the design and execution of experiments related to basic studies on Ecology, Physiology, Biochemistry, and use of plants as industrial resources or as human livelihood support systems.
- The students completing the course will be capable of understanding herbarium techniques.



Semester-III

Undergraduate Diploma in Botany

Discipline Specific Elective : Plant Tissue Culture

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Tissue Culture	4	4	0	0	Undergraduate certificate in Botany	Nil

UNDERGRADUATE DIPLOMA IN BOTANY

Programme: Undergraduate Diploma in Botany		Year:II	Semester:III
Subject:Botany			
Course:BOT DSE 1	Plant Tissue Culture		
CourseOutcomes: The successful students will be able to: 1. Learn the basic concepts, principles and processes in plant cell and tissue culture. 2. Understand the use of tissue culture techniques in plant improvement. 3. Apply the concepts and principles of plant cell and tissue culture in biotechnological and agricultural fields.			

Credits: 4	Discipline Specific Elective
Max. Marks : As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Introduction and historical background of Plant tissue culture. Principle, scope, utility and advantage of plant tissue culture, totipotency, general laboratory techniques, equipments (autoclave, laminar air flow, and incubator shaker) and their working principle, sterilization techniques, media preparation, plant growth regulators.	15
2	Callus and its types, callus differentiation and organogenesis, callus culture. Concept of clonal propagation, <i>In-Vitro</i> root and shoot propagation, different types of cultures (solid and suspension cultures).	15
3	Somatic embryogenesis and synthetic seeds, protoplast isolation and culture, somatic hybridization, somaclonal variation, cryopreservation.	15
4	Demonstration of tools and techniques used in plant tissue culture laboratory. Sterilization of media, instruments, and explants, formulation of Murashige and Skoog (MS) medium.	15

Suggested Readings

- Bhojwani, S.S. and Dantu, P.K. (2013). Plant Tissue Culture: An Introductory Text Springer
- Bhojwani, S.S. and Razdan, M.K. (1996). Plant Tissue Culture: Theory and Practice, Revised Edition, Elsevier
- Bhojwani, S.S., Bhatnagar, S.P. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
- Bhojwani, S.S. (1990). Plant Tissue Culture: Applications and Limitations (Elsevier).
- Collins, H.A. and Edwards, S. (1998). Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
- Jain, S.M., Sopory, S.K. and Veilleux, R.E. (1996). In Vitro Haploid Production in Higher Plants, Vols. 1-5., Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Kartha, K.K. (1985). Cryopreservation of Plant Cells and Organs. CRC

Press, Boca Raton, Florida, USA.

- Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, 2nd Edition Springer.
- Vasil, I.K. and Thorpe, T.A. (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.

Semester-IV

Undergraduate Diploma in Botany

DISCIPLINE SPECIFIC ELECTIVE (DSE) - Ethnobotany

No. of Hours - 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Ethnobotany	4	4	0	0	Undergraduate certificate in Botany	

UNDERGRADUATE DIPLOMA IN BOTANY

Programme: Undergraduate Diploma in Botany			Year: II	Semester: IV
Subject: Botany				
Course: BOT DSE 2	Ethnobotany			

Course Outcomes:

The successful students will be able to:

1. Learn the proper documentation and presentation of traditional knowledge about plants.
2. Use important plants used by the tribal communities for various purposes.
3. Learn the conservation of wild growing plants and their socio-economic impacts.

Credits:4	Discipline Specific Elective
Max.Marks:As per Univ. rules	Min.Passing Marks:As per Univ.rules

Unit	Topic	No. of Hours (60)
1	Introduction, concept, scope and objectives of ethnobotany; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals/tribes of India with special reference to Uttarakhand and their lifestyles. Plants used by the tribal communities.	15
2	Importance of a) Field work b) Herbarium c) Ancient Literature d) Temples and sacred places e) Indigenous knowledge system in ethnobotanical studies. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).	15
3	Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) <i>Azadirachta indica</i> b) <i>Ocimum sanctum</i> c) <i>Vitex negundo</i> d) <i>Gloriosa superba</i> e) <i>Tribulus terrestris</i> f) <i>Pongamia pinnata</i> g) <i>Cassia fistula</i> h) <i>Indigofera tinctoria</i> . Role of ethnobotany in	15

	modern medicine <i>Rauwolfia serpentina</i> , <i>Trichopus zeylanicus</i> ,	
	<i>Artemisia</i> , <i>Withania</i> as example.	
4	Visit to local sites for documentation of ethnobotanically important plants. Preparation of ethnobotanical profile of a tribal community, listing and identification of plants used by tribal communities. Documentation of herbal remedies used by local healers.	15

Suggested Readings

- Colton C.M. (1997). Ethnobotany-Principles and applications. John Wiley and sons Chichester.
- Jain S.K. (1981). Glimpses of Indian Ethnobotany, Oxford and IBH, New Delhi.
- Jain S.K. (1989). Methods and approaches in ethnobotany. Society of Ethnobotanists, Lucknow, India.
- Jain S.K. (1990). Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
- Jain S.K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- Rajiv K. Sinha (1996). Ethnobotany The Renaissance of Traditional Herbal Medicine-INA -SHREE Publishers, Jaipur).
- Rama Rao, Nand A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.

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Semester-V

Bachelor of Science in Botany

No. of Hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE)-Conservation and Management of Natural Resources

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Conservation and Management of Natural Resources	4	4	0	0	Undergraduate diploma in Botany	Nil

BACHELOR OF SCIENCE IN BOTANY

Programme: <i>Bachelor of Science in Botany</i>		Year: III	Semester: V
Subject: Botany			
Course: BOT DSE 3	Conservation and Management of Natural Resources		
Course Outcomes: The successful students will be able to: 1. Understand the importance, benefits and services of biodiversity. 2. Learn the strategies for the conservation of biodiversity.			

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Plant diversity and its scope- Genetic diversity, Species diversity, ecosystem diversity, Agrobiodiversity and cultivated plant taxa, wild taxa, Endemic species. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation. Loss of Biodiversity; Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Present scenario for biodiversity loss.	15
2	Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Red and Green data book, Biodiversity information management and communication.	15
3	Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, <i>In situ</i> and <i>ex situ</i> conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. Role of plants in Human Welfare: a) Importance of forests their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important cereals, pulses, vegetables, fruits, fibers, oils, spices, medicinal plants and their commercial importance. Wood and its uses. National and state institutes related to the activity.	15
4	Visit to a biodiversity-related institution (e.g., herbarium, botanic garden, forest department nursery) or in situ conservation site (e.g., sacred grove, national park) and ex situ conservation site (e.g., seed bank, botanical garden, nursery). Identification and ethno botanical documentation of at least 10 important plants used for food (cereals, pulses, fruits, spices), fiber,	15



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oil, beverages, and medicine.	
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Suggested Readings

- Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California
- Baskin and Baskin, (2001). Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination Elsevier
- Kormondy, E.J. (2017). Concept of Ecology. Pearson India.
- Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity – Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
- Odum, E.P. (1983). Basic Ecology Saunders, Philadelphia
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Smith, R.L. (1996). Ecology and Field Biology Harper Collins, New York.

Semester-VI

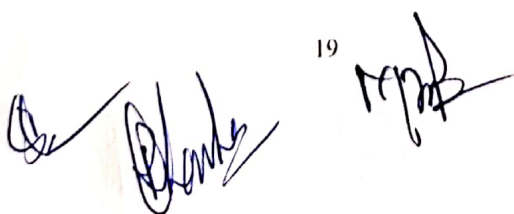
Bachelor of Science in Botany

DISCIPLINE SPECIFIC ELECTIVE (DSE)-Fundamentals of Molecular Biology
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No. of hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
BOTDSEVI Fundamentals of Molecular Biology	4	4	0	0	Undergraduate diploma in Botany	Nil



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BACHELOR OF SCIENCE IN BOTANY			
Programme: <i>Bachelor of Science in Botany</i>		Year: III	Semester: VI
Subject: Botany			
Course: BOT DSE 4	Fundamentals of Molecular Biology		
Course Outcomes:			
The successful students will be able to:			
• Understand the structure of nucleic acids and their types. • Understand key events of Molecular biology comprising mechanism of DNA replication, transcription and translation in Prokaryotes and Eukaryotes. • Learn about the genomes and gene structure.			

Credits: 4		Discipline Specific Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours (60)
1	Nucleic acids as genetic material (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment), Structure and functions of Nucleic acids. Genome and its organization: (genes, coding sequence, regulatory sequence, intron, exon, nucleosome structure and packaging of DNA into higher order structures).	15
2	DNA replication, genetic code, principles of gene regulation, negative and positive regulation, concept of lac and trp operons, and regulation of gene expression. Damage and repair of DNA: Causes (spontaneous, chemical agent, radiation) and types of DNA damage and mechanism of DNA repair.	15
3	Genomes and gene structure: gene families, transcriptomics,	15

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	proteomics and biological databases. Genome sequencing techniques and applications: Sequencing strategies, the shotgun method, massively parallel sequencing and its applications, and next-generation sequencers. Cloning: Cloning vectors, c-DNA synthesis and cloning, genomic DNA and c-DNA libraries, Enzymes used in recombinant DNA techniques, and molecular markers, brief idea of CRISPR-Cas, Polymerase Chain Reaction, Electrophoresis, DNA fingerprinting and blotting techniques.	
4	Introduction to biological databases (NCBI, EMBL, DDBJ, UniProt): searching for gene/protein sequences and Basic BLAST analysis to find sequence similarity. Demonstration of PCR (Polymerase Chain Reaction) and Agarose gel electrophoresis—loading, running, and analyzing DNA.	15

Suggested Readings

- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York, USA.
- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). Molecular Biology of the Cell. Garland Publishing Inc., New York. 6th edition.
- Watson, J.D. (2013). Molecular Biology of the Genes, Benjamin. 7th Edition.
- Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
- Lewin, B. (2000). Genes VII. Oxford University Press, New York.
- Wolfe, S.L. (1993). Molecular and Cellular Biology. Wadsworth Publishing Co. California.
- Stent, G.S. (1986). Molecular genetics. Bishen Singh Mahendra Pal Singh, Dehradun.
- Barry, J.M. and Barry, B.M. (1973). Molecular Biology, Prentice Hall of India. New Delhi.

Semester VII

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Biotechnology	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY		
Programme: <i>Honours Degree in Botany</i>		Year: IV Semester: VII
Subject: Botany		
Course: BOT DSE 5	Course Title: Plant Biotechnology	
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the process and techniques involved in bio-technology and plant tissue culture. 2. Analyze the tools and methodologies used in genetic engineering 3. Evaluate the methods and applications of recombinant DNA technology. 4. Understand the blotting techniques, DNA sequencing, and plant genetic engineering.		

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours(60)
1	Biotechnology: Principle and scope, bio-safety guidelines. Plant cell and tissue culture: Concept of cellular totipotency, principle of root and shoot generation <i>in vitro</i> , clonal propagation, applications of cell and tissue culture. Callus culture, organ culture, cell suspension culture, cryopreservation, protoplast culture, organogenesis, somatic embryogenesis, artificial seed, somatic hybridization, hybrids and cybrids, and somaclonal variation.	15
2	Recombinant DNA technology: Tools of genetic engineering, enzymes, cloning vectors (plasmids, cosmids, lambda phage, shuttle vectors, BACs, and YACs). Cloning strategies, Screening and selection of transformants.	15
3	Gene libraries (a general account): Genomic DNA libraries, cDNA libraries. Hybridization-colony hybridization, Southern hybridization, Northern hybridization, Western hybridization, DNA sequencing techniques: Maxam and Gilbert sequencing, Sanger sequencing. Genetic Engineering of plants: Aims, transformation techniques (<i>Agrobacterium</i> mediated transformation, electroporation, microinjection, and biolistics), strategies for development of transgenic plants with suitable examples (Golden rice, flavr-savr tomato, Bt cotton, moon dust carnations). Biosafety of transgenic plants.	15
4	Micropipetting Techniques (Learn accurate pipetting techniques). Preparation of Solutions and Buffers (Prepare standard solutions and buffers used in biotechnology labs). DNA Extraction (Extract and purify DNA from biological samples). Polymerase Chain Reaction (PCR) (Amplify specific DNA sequences).	15

Suggested readings

- Brown, T.A. (2018). Genomes 4. John Wiley and Sons (Asia) Pvt. Ltd. Singapore.
- Chrispeels, M.J. and Gepts, P. (2017). Plants, Genes and Agriculture. Oxford University Press.

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- Rai, A. C. (2009). Plant Biotechnology Laboratory Manual. I.K. International Publishing House. (A comprehensive manual offering a wide range of plant biotechnology experiments).
- Jolles, O. and Jornvall, H. (2000). Proteomics in Function Genomics. Birkhauser, Verlag, Basel, Switzerland.
- Shantharam, S. and Montgomery, J. F. (1999). Biotechnology, Biosafety and Biodiversity. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Collins, H. A. and Edwards, S. (1998). Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
- Callow, J. A., Ford-Lloyd, B. V. and Newbury, H. J. (1997). Biotechnology and Plant Genetic Resources: Conservation and Use. Cab International, Oxon, UK.
- Jain, S. M., Sopory, S. K. and Veilleux, R. E. (1996). In Vitro Haploid Production in Higher Plants, Vols. 1-5., Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Glazer, A. N. and Nikaido, H. (1995). Microbial Biotechnology, W. H. Freeman and Company, New York, USA.
- Primose, S. B. (1995). Principles of Genome Analysis. Blackwell Science Ltd, Oxford, UK.
- Vasil, I. K. and Thorpe, T. A. (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.
- Bhojwani, S. S. (1990). Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
- Kartha, K. K. (1985). Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.

Semester VII

DISCIPLINE SPECIFIC ELECTIVE (DSE) - AN INTRODUCTION TO MICROBIOLOGY

No. of Hours - 60

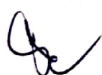
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Microbiology	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS		
Programme: <i>Bachelor of Botany With Honours</i>		Year: IV Semester: VII
Subject: Botany		
Course: BOT DSE 6	Course Title: An Introduction to Microbiology	
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the occurrence, general characters, types, reproduction and life cycle of the major microbial groups and their role in food, clinical and industrial microbiology. 2. Evaluate the classificatory approaches and advances in bacterial, viral and lichen taxonomies. 3. Demonstrate proficiency in basic microbiological techniques, including microscopy, bacterial staining, culture methods, and biochemical tests for microbial identification. 4. Explain the factors affecting microbial growth, including environmental conditions, nutritional requirements, and growth kinetics, and apply principles of microbial control and sterilization.		

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	General account of Microorganisms: History of microbiology, Golden Era of Microbiology, characteristic features of bacteria, General account of actinomycetes, classification of microorganism-five kingdom classification, Microbial growth-measurement of microbial growth, Batch, Fed-batch and continuous culture, endophytic microorganisms.	15
2	Morphology and structure of bacterial cells: Morphology of bacterial cells based on size, shape and arrangement, fine	15





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	structure of bacterial cells (of both Gram negative and Gram positive bacteria) capsule, cell wall, cell appendages (flagella, fimbriae, pili), Structure of plasma membrane, cytoplasmic inclusions- mesosomes, chlorosome. Ribosome- Site of protein synthesis, Microbial genetics- transformation, conjugation and transduction.	
3	Morphology and structure of viruses: History, morphology, fine structure, shape and classification of viruses. Mycophages and prions, Tobacco mosaic virus (TMV), T4 Bacteriophage and HIV- their fine structure, genome organization and multiplication, Bacteriophage therapy, Overview of Corona virus. Medical microbiology, Aquatic microbiology, Aeromicrobiology, Food microbiology, Soil Microbiology, Industrial microbiology, Geochemical microbiology.	15
4	Microscopy Techniques (Introduce students to basic microscopy techniques and observation of microorganisms). Bacterial Staining: Gram Staining (Differentiate between Gram-positive and Gram-negative bacteria). Microbial Identification: Biochemical Tests (Identify unknown bacterial species based on biochemical characteristics). Antimicrobial Sensitivity Test (Determine the susceptibility of bacteria to antibiotics).	15

Suggested readings

- Tortora, G.J., Funke, B.R. and Case C.L. (2021). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 13th edition.
- Madigan, Bender, Buckley, Sattley, Stahl. (2019). Brock Biology of Microorganisms. Pearson. 15th edition.
- Cappuccino, J.G., Welsh, J. (2019). Microbiology: Laboratory Manual. Pearson.
- Marjorie, Kelly. and Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw Hill New York, 5th edition.
- Kathleen Park, Talaro and Barry Chess. (2017). Foundations in Microbiology. McGraw Hill New York, 10th edition.
- Willey, Joanne, Sherwood, Linda., Woolverton, Christopher J. (2017). Prescott's Microbiology. McGraw Hill New York, 11th edition.

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- Cappuccino, J.G., Sherman, N. (2016). Microbiology: A Laboratory Manual. Pearson.
- Harley, J.P. (2013). Microbiology: Laboratory Exercises. McGraw-Hill Education.
- Mukherjee, K.G. and Singh V.P. (1997). Frontiers in Applied Microbiology. Rastogi Publ. Meerut.
- Power, C.B. and Dagainawala H.F. (1996). General Microbiology. Vol 2. Himalaya Pub. House, New Delhi.
- Kaushik, P. (1996). Introductory Microbiology. Emkay Publ, Delhi.
- Pelczar, M.J., Chan, ECS and Kreig, N.R. (1993). Microbiology. McGraw Hill, New York. Fifth Edition.
- Alexander, M. (1991). Microbial Ecology. John Wiley and Sons. New York.
- Doelle, H.W. and C.G. Heden (1986). Applied Microbiology, Kulwer Academic Press, London.
- Miller, B.M. and W. Litsky (1976). Industrial Microbiology. McGraw Hill New York.

Semester VII

No. of Hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE)- PLANT DEVELOPMENT AND REPRODUCTIVE BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Development and Reproductive Biology	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

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Programme: <i>Bachelor in Botany With Honours</i>		Year: IV	Semester: VII
Subject: Botany			
Course: BOT DSE 7	Course Title: Plant Development and Reproductive Biology		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the morphological characteristics of flower. 2. Study the fundamental concepts of root, shoot and leaf development. 3. Understand various stages of plant development. 4. Understand the developmental biology of male and female gametophyte, pollen-pistil interaction. 5. Study the basic idea of embryogenesis and seed development process, apomixes and polyembryony.			

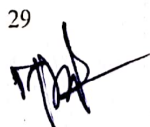
Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Morphology: Morphology of flower, stamen and carpel, Floral characteristics, structure of the pistil, Pollen-stigma interactions, Plant adaptations—physiological and their morphological characteristics (xerophyte, hydrophyte and halophyte). Shoot development: Organization of the shoot apical meristem (SAM): control of cell division and tissue differentiation especially xylem and phloem: secretory ducts and laticifers. Leaf growth and differentiation, structural development and classification of stomata and trichomes.	15
2	Root Development: Organization of root apical meristem (RAM), vascular tissue differentiation, lateral root, root hairs,	

	ABCD model of flower, Florigen pathway. Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, pollen germination, pollen tube growth and guidance, pollen allergy. Female gametophyte: Ovule development, megasporogenesis, development and organization of the embryo sac, structure of the embryo sac cells.	15
3	Pollination: pollination mechanism and vectors. Pollen-pistil interaction and fertilization: pollination mechanism and vectors, sporophytic and gametophytic self-incompatibility, double fertilization. Seed development and fruit growth: Endosperm development during early maturation and desiccation stages: embryogenesis, cell lineages during late embryo development, polyembryony, apomixis. Latent life- dormancy: Importance and types of dormancy, seed dormancy, bud dormancy.	15
4	To study the androecium and gynoecium of different families. To study the type of inflorescence of different families. Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma), complex and secretory tissues. Anatomy of monocot and dicot stem; monocot and dicot leaf; monocot and dicot root. Adaptive anatomy: Xerophytes, Hydrophytes, Epiphytes Normal and abnormal secondary growth in different plants. To study the type of anthers and T.S. of the anther To study the pollen grains of different families. To study the types of placentation. To study the types of pollination and seed dispersal mechanisms (photographs and specimens)	15

Suggested readings

- Bhatnagar S.P, Dantu, P.K. Bhojwai S.S. (2018). The embryology of Angiosperms. Vikas Publ. House. New Delhi.
- Lalit M. Srivastava. (2002). Plant Growth and Development. Hormones and


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Environment. Academic Press. 1st Edition.

- Raghavan V. (1999). Developmental biology of flowering plants. Springer Verlag. New York.
- Howell, S.H. (1998). Molecular genetics of plant Development. Cambridge Univ. Press.
- Fonkot, Dc. (1994). Plant growth and Development. A molecular approach. Academic Press. San Diego.
- Lyndon. R.F. (1990). Plant Development. The Cellular Basis. Unn in Hyman. London.

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE (DSE)-CYTOGENETICS

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Cytogenetics	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: Bachelor in Botany With Honours		Year: IV	Semester: VIII
Subject: Botany			
Course: BOT DSE 8	Course Title: Cytogenetics		

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Course Outcomes:

After the completion of the course the students will be able to:

1. Apply the concepts of Mendelian genetics to solve problems on linkage, crossing over and gene mapping.
2. Analyze human pedigree and apply the principles of population genetics to work out problems on genotype frequency and Hardy-Weinberg equilibrium. Understand the Chromosomal aberrations and their role in genome evolution with special reference to crop plants.
3. Understand modern breeding methods in improving agricultural crop varieties.
4. Understand the process of cell cycle its regulation and the mechanism of apoptosis.

Credits:4	Discipline Specific Elective
Max.Marks: As per Univ.rules	Min.Passing Marks: As per Univ.rules

Unit	Topic	No.of Hours (60)
1	Mendelian principles: Dominance, Segregation, independent assortment; extension of Mendelian principles (co dominance, incomplete dominance, gene interactions, pleiotropy); linkage and crossing over, sex linked, sex limited and sex influenced characters. Genetic recombination and gene mapping: Recombination, role of RecA and RecB, C, D enzymes, gene mapping methods (linkage maps, tetrad analysis, mapping with molecular markers); population genetics- gene pool, gene frequency, Hardy-Weinberg law.	15
2	Structural and numerical alterations in chromosome: Origin, meiotic behaviour and consequences of duplication, deletion, inversion and translocation. Mutation: spontaneous and induced mutation; physical and chemical mutagens; molecular basis of mutation; DNA damage and repair mechanisms; transposable elements, mutations induced by transposons; cell cycle and apoptosis, cancer at cellular level.	15
3	Chromosome structure: Packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes; euchromatin and heterochromatin;	15

	NuclearDNAcontent,C-valueparadox;Cot-curvesandtheir significance Genestructureandexpression:geneticfinestructure;cis-transtest; introns andexons; RNA splicing multiple alleles, pseudoallele, regulation of gene expression in prokaryotesand eukaryotes.	
4	To study Mendelian and Non- Mendelian gene interaction ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) through seeds. Evaluate the genetic hypothesis employing the Chi square test To observe the various stages of mitosis and meiosis with the help of onion root tip and bud respectively.	15

Suggested readings

- Lodish, H., Berk, A., Zipursky, S.L. Maztsudaira, P., Baltimore, D and Darnell, I. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York, USA.
- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). Molecular Biology of the Cell. Garland Publishing Inc., New York. 6th edition.
- Watson, J.D. (2013). Molecular Biology of the Genes, Benjamin. 7th Edition.
- Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
- Lewin, B. (2000). Genes VII. Oxford University Press, New York.
- Atherly, A.G., Girton, J.R. and McDonald, J.F. (1999). The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
- Gupta, P.K. (1998). Cytogenetics. Rastogi Publications, Meerut.
- Hartl, D.L. and Jones, E.W. (1998). Genetics: Principles and Analysis (4th Edition). Jones and Bartlett Publishers, Massachusetts, USA.
- Malacinski G.M.D. and Freifelder, D. (1998). Essentials of Molecular Biology (3rd Edition). Jones and Bartlett Publishers, Inc. London.
- Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
- Wolfe, S.L. (1993). Molecular and Cellular Biology. Wadsworth Publishing Co. California.

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE (DSE)- ECOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

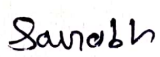
Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Ecology	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

BACHELOR IN BOTANY WITH HONOURS			
Programme: <i>Bachelor in Botany with Honours</i>		Year: IV	Semester: VIII
Subject: Botany			
Course: BOT DSE 9	Course Title: Ecology		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the scope and concepts of ecology and discuss the biosphere, biomes and biogeography. 2. Analyze the process of ecological succession. 3. Evaluate the importance of the major world ecosystems. 4. Distinguish between species, populations, communities, ecosystem and biomes.			

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules



Unit	Topic	No. of Hours (60)
1	Major terrestrial biomes; Zonoecotones, Orobiomes and Pedobiomes, Freshwater aquatic ecosystems; Marine ecosystems. Community structure and attributes; Edges and ecotones; Keystone species and control of community structure. Types of species interactions, herbivory, carnivory, pollination, symbiosis (obligate and facultative symbiosis).	15
2	Population Ecology: Characteristics of population; population growth curves; population regulation life history strategies (r and K selection); population genetics and natural selection. Habitat and niche: Concept of habitat and niche; niche width and overlap, fundamental and realized niche. Biodiversity: Levels of Biodiversity, Uses of biodiversity; Biodiversity, ecosystem services and functions. Distribution of biodiversity; Gradients of biodiversity; Hotspots; Threats to biodiversity, Key stone species. Extinction of species: Biodiversity assessment and inventory; Conservation of biodiversity; Indices; Biodiversity and its conservation; International efforts for conserving biodiversity. Climate change and conservation: Greenhouse gases; sources, trends and role; ozone layer and ozone hole; Consequences of climate change; Principles of conservation.	15
3	Ecological succession: Causes, mechanism and types, changes involved in succession; Concept of climax. Ecosystem: Structure and functions; energy dynamics (Tropical organization, energy flow pathways, ecological efficiencies); litter fall and decomposition (mechanism, substrate quality and climatic factors); Global biogeochemical cycles of C, N, P and S (pathways, processes in terrestrial and aquatic ecosystems); nutrient use efficiency; Global hydrological cycle.	15
4	Vegetation analysis for Community Structure: Quadrat Method, Importance Value Index (IVI), Distribution pattern, Shannon Index (Shannon and Weiner Index), Simpson's index (Concentration of dominance). Population Structure and Regeneration Status, Estimation of Plant Biomass. Estimation of Net Primary Productivity, Forest Floor Biomass, Measurement of leaf area.	15

Suggested readings

- Kormondy, E.J. (2017). Concept of Ecology. Pearson India.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Baskin and Baskin, (2001). Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination Elsevier.
- Smith, R.L. (1996). Ecology and Field Biology Harper Collins, New York
- Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California
- Odum, E.P. (1983). Basic Ecology Saunders, Philadelphia.

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE (DSE)- PLANT SYSTEM PHYSIOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant System Physiology	04	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: Bachelor in Botany with Honours	Year: IV	Semester: VIII
Subject: Botany		

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Course: BOT DSE 10	Course Title: Plant System Physiology
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the mechanism of transport and translocation of water and analyze the mechanisms of acclimation and adaptation of plants to stress conditions. 2. Understand the process of transpiration, photosynthesis and respiration and analyze these processes in various groups of plants. 3. Gain awareness on the nitrogen cycle and the role of microbes and plants in the nitrogen cycle. 4. Understand the role of plant growth regulators and photoreceptors in plant growth and development. 5. Demonstrate the ability to measure the rate of photosynthesis using various techniques and interpret the results in relation to light intensity and other environmental factors. 6. Perform chlorophyll extraction and use spectrophotometry to quantify chlorophylls in plant tissues, understanding their role in photosynthesis and plant health. 7. Design and conduct experiments to study the effects of various environmental factors, including light and temperature, on seed germination and seedling development.	

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Membrane transport and translocation of water and solutes: Plant – water relations, mechanism of water transport through xylem, phloem loading and unloading, passive and active solute transport, membrane transport of proteins. Signal transduction and sensory photobiology: Receptors, phospholipids signaling, phytochromes and cryptochromes.	15





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2	Photosynthesis: General concepts and historical background, steps of photosynthesis, Emerson's effect, two pigment systems, Calvin cycle, photorespiration and its significance. C4 cycle, CAM pathway Respiration: Glycolysis, TCA cycle, electron transport chain and ATP synthesis, pentose-phosphate pathway, glyoxylate cycle. Nitrogen fixation and metabolism: Biological nitrogen fixation, mechanism of nitrate uptake and reduction, ammonia assimilation.	15
3	Plant growth regulators: Physiological effects and mechanism of auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines, jasmonic acid, Hormone receptors and vitamins, phytochrome and cryptochrome. Photoperiodism and vernalization and their significance; Floral induction and development Plant movements. Stress physiology: Plant responses to biotic and abiotic stresses, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, freezing and heat stress, oxidative stress.	15
4	To measure the rate of photosynthesis in aquatic plants using the floating leaf disk assay. To determine the stomatal density on the leaves of different plant species. To measure the rate of transpiration in plants using a potometer. Measure the rate of respiration in plant tissues. To extract and quantify chlorophyll from plant leaves using spectrophotometry.	15

Suggested readings

- Taiz, L; Zeiger, E; Moller, I. M. and Murphy A. (2023). Plant Physiology and Development. Publisher: Sinauer Associates print of Oxford University Press. 6th Edition.
- Huner, N.P.A, and Hopkins, W.G. (2008). Introduction to Plant Physiology. Wiley 4th Edition.
- Devi, P. (2000). Principles and methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios.
- Buchanan, B.B, Gruissem W. and Jones, R.L. (1996). Biochemistry and Molecular Biology of plants by Enzymes: A practical introduction to structure, mechanism and data analysis. R.A. Copeland.
- Scott, R.P. W. (1995). Techniques and Practice of Chromatography. Taylor and Francis, Routledge.

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Semester IX

DISCIPLINE SPECIFIC ELECTIVE (DSE) – EVOLUTIONARY BIOLOGY OF PLANTS

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Evolutionary Biology of Plants	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: Bachelor in Botany With Honours

Year: V

Semester: IX

Subject: Botany

Course: BOT DSE 11

Course Title: Evolutionary Biology of Plants

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the essential theories of evolution
2. Differentiate between micro and macro evolution and the forces shaping evolution
3. Construct phylogenetic trees based on morphological and molecular data
4. Understand the evolution of life and different groups of plants.

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Historical Perspective of evolutionary concepts: Pre-Darwinian ideas, Lamarckism, Darwinism, Post-Darwinian era – Modern synthetic theory, Neo-Darwinism, Pre-biotic conditions and events; Evolution of eukaryotes from prokaryotes.	15
2	Evidences of Evolution: Paleobiological– Concept of Stratigraphy and geological timescale; fossil study, Taxonomic –Transitional forms/evolutionary intermediates, living fossils. Microevolution and Macroevolution: Hardy Weinberg equilibrium; Founder effect, Natural and artificial selection. Levels of selection. Gene trees, species trees; Patterns of evolutionary change, Mutation, Gene flow, Selection, Genetic Drift, Co-evolution.	15
3	Evolution of Land Plants: Species concept, Modes of speciation – Allopatric; sympatric; peripatric; Origin of land plants – Terrestrial algae and bryophytes; Early vascular plants – Stelar evolution; seed habit and evolution of seed, adaptive strategies of different group of plants.	15
4	Study of Lamarckism, Darwinism, and Neo-Darwinism through the (Specimens/slides/photographs) various examples. Study of different types of fossils, connecting links/transitional forms and Living fossils (Specimens/slides/photographs) To study the various evolutionary events in geological timescale through the (specimens/slides/photographs). Sampling of quantitative characters (continuous and discontinuous) in a population (height, weight, number of nodes etc).	15

Suggested readings

- Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
- Ridley, M. (2004). Evolution. III Edn. Blackwell Pub., Oxford.
- Hall, B.K., Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett.
- Zimmer, C., Emlen, D.J. (2013). Evolution: Making Sense of Life. Roberts & Co.
- Futuyma, D. (1998). Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
- Barton, Briggs, Eisen, Goldstein and Patel. (2007). Evolution. Cold Spring Harbor Laboratory Press.
- k, M. (2017). Evolution, 4th Ed. Sinauer, Sunderland, MA: Sinauer Associates.

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Semester IX

DISCIPLINESPECIFICCOURSE(DSE)-PLANTPATHOLOGY

No.ofHours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

CourseTitle	Credits	CreditdistributionoftheCourse			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Plant Pathology	4	4	0	0	Honours Degreein Botany	Nil

MASTEROFSCIENCEINBOTANY

MASTEROFSCIENCEINBOTANY			
Programme: <i>MasterofScienceinBotany</i>		Year: V	Semester: IX
Subject: Botany			
Course: BOT DSE 12	Course Title: Plant Pathology		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the general characteristics of plant pathogenic organisms including fungi, bacteria, viruses and mycoplasma. 2. Study the interactions between plant and pathogen in relation to the environment and mechanism of disease development by pathogens. 3. Understand the genetics of host parasite interaction. 4. Understand the various enzymes and toxins involved in disease development. 5. Study various important plant diseases, their disease cycle and control measures.			

Credits:4	Discipline Specific Elective
Max.Marks: Asper Univ.rules	Min.Passing Marks:Asper Univ. rules

Unit	Topic	No. of Hours (60)
1	A brief history of plant pathology in India Types of pathogens, symptoms of different plant diseases. Inoculum: Inoculum types, theory of inoculums, survival and longevity of inoculums, inoculums production, potential and density. Plant microbe interaction: molecular basis of host recognition, pathogenesis: pre-penetration, penetration and post penetration events, factors affecting disease development (host factors, environmental factors, virulence susceptibility). Dissemination of pathogens: Means of dissemination (active and passive dissemination). Genetics and host parasite interaction: Concept of compatibility and specificity, gene for gene relationship, genetics of resistance, source of resistance, inheritance of resistance in the host. Enzymes and toxins: Enzymes involved in disease development, toxins and their role in plant health.	15
2	Disease resistance: (i) Protection (structural, chemical, absence of nutrients and common antigens). Defense (histological defense, chemical-polyphenols, prohibitins, inhibitins, phytoalexins, lectins). Genetic resistance: resistant genes, biotechnological approaches for transfer of R-genes into susceptible plant. Seed pathology: Seed borne pathogens, mechanism of seed infections in field and during storage, transmission of pathogens through seeds, seed health testing methods, market disease of fruits and vegetables. Disease control: Cultural practices, chemical methods (insecticides, systemic and non-systemic chemical), biological control: Introduction, Biological control of insects and pests, use of resistance varieties and plant quarantine.	15
3	Brief account, structure, importance, disease cycle and control of the following diseases: (i) Damping-off, (ii) Wilt, (iii) Root rot, stem rot and fruit rot (iv) Mildews (powdery and downy), (v) Rusts, smuts, (vi) Leaf	15

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	spots and leaf blights. General characteristics, importance, disease cycle and control of the following: (i) Bacterial disease, (ii) Viral disease, (iii) Mycoplasma disease.	
4	Study of various instruments used in Plant Pathology laboratory. Media preparation, isolation and culturing of plant pathogens Study of various fungal, bacterial and viral diseases - symptoms with the help of live or preserved specimens / digital resources. Study of causal organism with the help of temporary tease/section mounts.	15

Suggested readings

- Mehrotra, R.S. (2013). Plant Pathology. Tata McGraw Hill Publishing Co Ltd. New Delhi.
- Agrios, G.N. (2011). Plant Pathology. Elsevier.
- Bouarab, N. K., N. Bissow and F. Daayf. (2009). Molecular Plant Microbe Interactions.
- Mehrotra, R.S. and Agrawal, A. (2003). Plant Pathology. Tata McGraw Hill Publishing Co Ltd. New Delhi.
- Lucas, J.A. (1988). Plant Pathology and Plant Pathogens. Third edition. Blackwell.
- Singh, R.S. (1988). "Plant diseases". Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Singh R.S. (2018). Plant Diseases. 10th Edition Medtech, New Delhi.
- Sharma, P.D. (2014). Plant Pathology. Rastogi Publications, Meerut.

Semester IX

DISCIPLINE SPECIFIC COURSE (DSE) – Protected Agriculture – Hydroponics and Organic Cultivation

No. of Hours - 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Protected Agriculture: Hydroponics and Organic Cultivation	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY

Programme: Master of Science in Botany

Year: V

Semester: IX

Subject: Botany

Course: BOT DSE 13

Course Title: Protected Agriculture: Hydroponics and Organic Cultivation

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand various aspects of hydroponics, aquaponics and organic cultivation.
2. Become economically self-reliant by growing and marketing organic herbs, vegetables, microgreens and fruits.
3. Gain practical training in establishing a hydroponic facility.
4. Understand good agricultural practices associated with protected agriculture.

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Introduction to protected agriculture: Types of protected agriculture (hydroponics, aquaponics and organic farming), definition, history, terminology, importance and advantages over traditional agriculture, limitations and challenges.	15
2	Plant growth requirements : Physical parameters - light (quality and quantity) artificial light, light balancers; pH, conductivity, salinity (Dissolved Oxygen-DO, Total Dissolved Solid - TDS) and temperature; Chemical parameters- mineral nutrient requirements, deficiencies, toxicities, growth regulators (auxins, gibberellins, cytokinins and abscisic acids); Growth media- types, properties, uses, nutrient formula and preparation of solutions.	15
3	Hydroponic growing systems: Basic concepts and designs (closed and open systems techniques, Nutrient Film Technique (NFT), Deep Water Culture (DWC), Dutch Bucket and other small-scale systems), systems layout. Strengths and weaknesses of various systems, site considerations, components and methods for nutrient delivery. Organic farming and its management: Organic farming and associated management practices. Marketing of the organic produce. Government institutes and policies related to protected farming. Pest and disease management.	15
4	Study of various instruments used in hydroponics. Preparation of growth media for hydroponics. Estimation of NPK, DO, TDS, pH of growing media. Demonstration of different irrigation techniques in hydroponics	15

Suggested readings

- Hasan, M., Sabir, N., Singh, A.K., Singh, M.C., Patel, N., Khanna, M., Rai, T., Pragnya, P. (2018). Hydroponics Technology for Horticultural Crops, Tech. Bull. TB-ICN 188/2018. Publ. by I.A.R.I., New Delhi-110012 INDIA.
- Misra S., Misra S., Misra R.L. (2017). Soilless Crop production. Daya Publishing House, Astral International (P) Ltd., New Delhi.
- Palaniappan S. P., Annadurai K. (2018). Organic Farming: Theory & Practice. Scientific Publisher. 5. Goddek, S., Joyce, A., Kotzen, B., Burnell, G.M. (2019). Aquaponics Food Production Systems. Springer, Cham.
- Jones, J.B. (2014). Complete Guide for Growing Plants Hydroponically. CRC Press.
- Vayas, S.C., Vayas, S., Modi, H.A. (1998). Bio-fertilizers and organic Farming. Akta Prakashan, Nadiad.

Semester X

DISCIPLINE SPECIFIC ELECTIVE (DSE) – BIOINFORMATICS AND BIOSAFETY NORMS

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Bioinformatics and Bio-safety Norms	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY		
Programme: <i>Master of Science in Botany</i>	Year: V	Semester: X
Subject: Botany		
Course: BOT DSE 14	Course Title: Bioinformatics and Biosafety Norms	
Course outcomes: After the completion of the course the students will be able to		
1. Understand the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field. 2. Learn about biological databases, sequence retrieval, alignment, and phylogenetic analysis using various tools. 3. Understand the basic concept of Intellectual Property rights		

Credits: 4		Discipline Specific Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours (60)
1	Introduction to Bioinformatics Historical background; Aims and scope; Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology. Role of bioinformatics in drug discovery; Applications and Limitations of bioinformatics.	15
2	Biological databases Introduction to biological databases - Primary, secondary and composite databases; Study of following databases: NCBI (GenBank, PubChem, PubMed and BLAST; introduction to EMBL, DDBJ, UniProt, PDB and KEGG.	15
3	Basic concepts of Intellectual Property Rights (IPRs). The implications of the Intellectual Property Rights on the Convention on Biological Diversity (CBD).	15

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4	Biological databases (NCBI, EMBL, UniProt, PDB) Literature retrieval from PubMed. Protein Structure retrieval from PDB (in pdb format) and visualisation by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol).	15
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Suggested readings

- Ghosh, Z., Mallick, B. (2008). Bioinformatics—Principles and Applications, 1st edition. New Delhi, Delhi: Oxford University Press.
- Baxevanis, A.D., Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
- Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
- Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
- Paroda. R.S. & R.K. Arora (1991). Plant Genetics Resources Conservation and Management concepts and approaches. New Delhi.
- Krattigar, F. Anatole. et al. (1994 Ed.) Widening Perspectives on Biodiversity. Dehradun.
- Yamin, F. (1995) The Biodiversity Conservation and Intellectual Property Rights. Switzerland.

Semester X

DISCIPLINE SPECIFIC ELECTIVE (DSE) – ADVANCES IN PLANT TAXONOMY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Advances in Plant Taxonomy	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY		
Programme: <i>Master of Science in Botany</i>		Year: V Semester: X
Subject: Botany		
Course: BOT DSE 15	Course Title: <i>Advances in Plant Taxonomy</i>	
Course outcomes: After the completion of the course the students will be able to		
1. Understand the naming of the plant through plant nomenclature. 2. Learn the phylogeny and classification of angiosperms of system their use and utility. 3. Identify various angiosperm families with specific key characters. 4. Learn various advanced tools used to study plant taxonomy. 5. Understand the latest molecular techniques used in plant taxonomy. 6. Explore the impact of bioinformatics on plant classification. 7. Study the role of phylogenetic analysis in plant taxonomy.		

Credits: 4		Discipline Specific Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours (60)
1	History of different systems of classification (introduction only). Important systems- Bentham and Hooker, Hutchinson, A. Takhtajan, A. Cronquist, Robert Thorne, Angiosperm Phylogeny Group (APG IV) classification. A brief account of major contributions made by the following taxonomists: C. Linnaeus, J.D. Hooker, William Roxburgh and Duthie., International Code of Nomenclature (ICN) for Algae, Fungi, and Plants.	15
2	Taxonomic tools, histological, cytological, phytochemical, serological, biochemical, and molecular techniques. Relevance of taxonomy to conservation. Modern techniques in plant taxonomy including: molecular phylogenetic, DNA Bar Coding, DNA extraction, amplification, sequencing and Digital herbarium database (Access Digital Herbarium DataBase) Search for records of your plant species and related taxa.	15

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	Compare your specimens with digital records. Use of Electrophoresis, PCR, HPLC and other instruments useful in molecular taxonomy, Operational Taxonomic Unit (OTU) and OTU Clustering.	
3	Some important families: Magnoliaceae, Myrtaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Amaranthaceae, Cannabaceae, Moraceae, Orchidaceae, Zingiberaceae, Cyperaceae, Poaceae. Update the plant nomenclature with different website (Plants of the World Online (PWO) Kew Science, Global Biodiversity Information Facility (GBIF) International Plant Nomenclature Index (IPNI), Tropicos), e-flora.	15
4	To study the vegetation type(s) and flora(s) of different areas in the local areas, and training in collection and preservation. To study the molecular techniques used in plant taxonomy. To study the advanced tools used in plant taxonomy	15

Suggested readings

- Kochhar S.L. (2016). Economic Botany. Cambridge University Press, London.
- Angiosperm Phylogeny Group (APG-2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1-20.
- Saxena, N.B. and Saxena, S. (2012). Plant Taxonomy. Pragati Prakashan.
- Sambamurthy A.V.S.S. (2010). Taxonomy of Angiosperms. I.K. International Pvt. Ltd.
- Singh, G. (2010). Plant Systematics. CBS PUB & DIST PVT Limited INDIA.
- Sharma, O.P. (2009). Plant Taxonomy. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Gaur R.D. (1999). Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.
- Bhattacharya B. and B.M. Joshi. (1998). Flowering plants. Taxonomy and phylogeny Norsa publishing house New Delhi.

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- Heywood V.H. and D.M. Moore. (1984). Current concepts in plant taxonomy. Systematics special volume 25. London.
- Davis P.H. and Heywood V.H. (1973). Principles of angiosperm taxonomy. Robert E. Kreigh Pub. Co. New York.
- Heywood V.H. (1970). Plant taxonomy London.
- Bensen L. (1957). Plant Classification reprint. Oxford & IBHN. Delhi.
- Lawrence G.H.M. (1951). Taxonomy of vascular plants. MacMillan N. York.

Semester X

DISCIPLINE SPECIFIC ELECTIVE (DSE) – PLANT BREEDING

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Breeding	04	4	0	0	Bachelor of Science in Botany	Nil

MASTERS OF SCIENCE IN BOTANY

Programme: Masters of Science in Botany		Year: V	Semester: X
Subject: Botany			
Course: BOT DSE 16	Course Title: Plant Breeding		

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Course Outcomes:

After the completion of the course the students will be able to:

- Understand the principles of plant breeding, including its important achievements and undesirable consequences of plant breeding.
- Understand the process of hybridization, advantages and limitations.
- Understand the plant breeding systems and heterosis and role of mutation in plant breeding.

Credits: 4

Discipline Specific Elective

Max. Marks: As per Univ. rules

Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Plant breeding: Introduction and objectives; breeding systems, important achievements and undesirable consequences of plant breeding); methods of crop improvement; Centres of origin and domestication of crop plants, plant genetic resources, acclimatization; selection methods	15
2	Hybridization: Hybridization technique for self-pollinated and cross-pollinated crops. Vegetatively propagated plants—procedure, advantages and limitations; Inbreeding depression and heterosis (history, genetic basis and applications). Crop improvement and breeding (role of mutations; polyploidy; distant hybridization and biotechnology in crop improvement).	15
3	Effects of aneuploidy on plant phenotypes; Transmission of monosomics and trisomics and their uses, Chromosome mapping of diploid and polyploidy species, evolution of major crop plants (wheat and rice).	15
4	Introduction to plant breeding techniques: handling and maintenance of breeding populations, Study of pollination mechanisms in self-pollinated and cross-pollinated crops, Selection methods: Demonstration of pure-line selection and mass selection methods. Study of polyploidy and its effects on plant morphology using prepared slides/specimens, Chromosome analysis: Karyotyping and chromosome mapping in diploid and polyploid species.	15

Suggested readings

- Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991). Principles of Genetics, John Wiley & Sons.
- Allard, R.W. (1999). Principles of Plant Breeding, John Wiley & Sons.
- Rastogi, V.B. (2019). Genetics. 4th Edition. MEDTECH: A Division of Scientific International.
- Russell, P.J. (2010). Genetics - A Molecular Approach, Pearson Education Inc.
- Singh, R.J. (2002). Plant Cytogenetics, CRC Press.
- Singh, B.D. (2005). Plant Breeding: Principles and Methods (7th Edition). Kalyani Publishers.
- Strickberger, M.W. (2008). Genetics, Pearson (Prentice Hall).
- Acquah, G. (2012). Principles of Plant Genetics and Breeding. Wiley-Blackwell.
- Watson, J.D. (2013). Molecular Biology of the Genes, Benjamin. 7th Edition.



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Semester-III

Undergraduate Diploma in Botany

Discipline Specific Elective: Plant Tissue Culture

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Tissue Culture	4	4	0	0	Undergraduate certificate in Botany	Nil

UNDERGRADUATE DIPLOMA IN BOTANY

Programme: Undergraduate Diploma in Botany		Year: II	Semester: III
Subject: Botany			
Course: BOT DSE 1	Plant Tissue Culture		
Course Outcomes: The successful students will be able to:			
1. Learn the basic concepts, principles and processes in plant cell and tissue culture. 2. Understand the use of tissue culture techniques in plant improvement. 3. Apply the concepts and principles of plant cell and tissue culture in biotechnological and agricultural fields.			

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Introduction and historical background of Plant tissue culture. Principle, scope, utility and advantage of plant tissue culture, totipotency, general laboratory techniques, equipments (autoclave, laminar air flow, and incubator shaker) and their working principle, sterilization techniques, media preparation, plant growth regulators.	15
2	Callus and its types, callus differentiation and organogenesis, callus culture. Concept of clonal propagation, <i>In-Vitro</i> root and shoot propagation, different types of cultures (solid and suspension cultures).	15
3	Somatic embryogenesis and synthetic seeds, protoplast isolation and culture, somatic hybridization, somaclonal variation, cryopreservation.	15
4	Demonstration of tools and techniques used in plant tissue culture laboratory. Sterilization of media, instruments, and explants, formulation of Murashige and Skoog (MS) medium.	15

Suggested Readings

- Bhojwani, S.S. and Dantu, P.K. (2013). Plant Tissue Culture: An Introductory Text Springer
- Bhojwani, S.S. and Razdan, M.K. (1996). Plant Tissue Culture: Theory and Practice, Revised Edition, Elsevier
- Bhojwani, S.S., Bhatnagar, S.P. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
- Bhojwani, S.S. (1990). Plant Tissue Culture: Applications and Limitations (Elsevier).
- Collins, H.A. and Edwards, S. (1998). Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
- Jain, S.M., Sopory, S.K. and Veilleux, R.E. (1996). In Vitro Haploid Production in Higher Plants, Vols, 1-5., Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Kartha, K.K. (1985). Cryopreservation of Plant Cells and Organs. CRC

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- Press, Boca Raton, Florida, USA.
- Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, 2nd Edition Springer.
 - Vasil, I.K. and Thorpe, T.A. (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.

Semester-IV

Undergraduate Diploma in Botany

DISCIPLINE SPECIFIC ELECTIVE (DSE)-Ethnobotany

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Ethnobotany	4	4	0	0	Undergraduate certificate in Botany	

UNDERGRADUATE DIPLOMA IN BOTANY

Programme: Undergraduate Diploma in Botany			Year: II	Semester: IV
Subject: Botany				
Course: BOT DSE 2	Ethnobotany			

Course Outcomes:

The successful students will be able to:

1. Learn the proper documentation and presentation of traditional knowledge about plants.
2. Use important plants used by the tribal communities for various purposes.
3. Learn the conservation of wild growing plants and their socio-economic impacts.

Credits:4	Discipline Specific Elective
Max.Marks:As per Univ. rules	Min.Passing Marks:As per Univ.rules

Unit	Topic	No. of Hours (60)
1	Introduction, concept, scope and objectives of ethnobotany; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals/tribes of India with special reference to Uttarakhand and their lifestyles. Plants used by the tribal communities.	15
2	Importance of a) Field work b) Herbarium c) Ancient Literature d) Temples and sacred places e) Indigenous knowledge system in ethnobotanical studies. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).	15
3	Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) <i>Azadirachta indica</i> b) <i>Ocimum sanctum</i> c) <i>Vitex negundo</i> d) <i>Gloriosa superba</i> e) <i>Tribulus terrestris</i> f) <i>Pongamia pinnata</i> g) <i>Cassia fistula</i> h) <i>Indigofera tinctoria</i> . Role of ethnobotany in	15

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	modern medicine <i>Rauwolfia serpentina</i> , <i>Trichopus zeylanicus</i> ,	
	<i>Artemisia</i> , <i>Withania</i> as example.	
4	Visit to local sites for documentation of ethnobotanically important plants. Preparation of ethnobotanical profile of a tribal community, listing and identification of plants used by tribal communities. Documentation of herbal remedies used by local healers.	15

Suggested Readings

- Colton C.M. (1997). Ethnobotany-Principles and applications. John Wiley and sons Chichester.
- Jain S.K. (1981). Glimpses of Indian Ethnobotany, Oxford and IBH, New Delhi.
- Jain S.K. (1989). Methods and approaches in ethnobotany. Society of Ethnobotanists, Lucknow, India.
- Jain S.K. (1990). Contribution of Indian ethnobotany. Scientific publishers, Jodhpur.
- Jain S.K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- Rajiv K. Sinha (1996). Ethnobotany The Renaissance of Traditional Herbal Medicine-INA -SHREE Publishers, Jaipur).
- Rama Rao, Nand A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.

Semester-V

Bachelor of Science in Botany

No. of Hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE)-Conservation and Management of Natural Resources

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Conservation and Management of Natural Resources	4	4	0	0	Undergraduate diploma in Botany	Nil

BACHELOR OF SCIENCE IN BOTANY

Programme: <i>Bachelor of Science in Botany</i>		Year: III	Semester: V
Subject: Botany			
Course: BOT DSE 3	Conservation and Management of Natural Resources		
Course Outcomes: The successful students will be able to: 1. Understand the importance, benefits and services of biodiversity. 2. Learn the strategies for the conservation of biodiversity.			

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Plant diversity and its scope- Genetic diversity, Species diversity, ecosystem diversity, Agrobiodiversity and cultivated plant taxa, wild taxa, Endemic species. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation. Loss of Biodiversity; Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Present scenario for biodiversity loss.	15
2	Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Red and Green data book, Biodiversity information management and communication.	15
3	Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, <i>In situ</i> and <i>ex situ</i> conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. Role of plants in Human Welfare: a) Importance of forests their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through hages. Fruits and nuts: Important cereals, pulses, vegetables, fruits, fibers, oils, spices, medicinal plants and their commercial importance. Wood and its uses. National and state institutes related to the activity.	15
4	Visit to a biodiversity-related institution (e.g., herbarium, botanic garden, forest department nursery) or in situ conservation site (e.g., sacred grove, national park) and ex situ conservation site (e.g., seed bank, botanical garden, nursery). Identification and ethnobotanical documentation of at least 10 important plants used for food (cereals, pulses, fruits, spices), fiber,	15

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oil, beverages, and medicine.	
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Suggested Readings

- Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California
- Baskin and Baskin, (2001). Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination Elsevier
- Kormondy, E.J. (2017). Concept of Ecology. Pearson India.
- Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity – Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
- Odum, E.P. (1983). Basic Ecology Saunders, Philadelphia
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Smith, R.L. (1996). Ecology and Field Biology Harper Collins, New York.

Semester-VI

Bachelor of Science in Botany

DISCIPLINE SPECIFIC ELECTIVE (DSE)-Fundamentals of Molecular Biology

No. of hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
BOTDSEVI Fundamentals of Molecular Biology	4	4	0	0	Undergraduate diploma in Botany	Nil

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BACHELOR OF SCIENCE IN BOTANY		
Programme: <i>Bachelor of Science in Botany</i>		Year: III Semester: VI
Subject: Botany		
Course: BOT DSE 4	Fundamentals of Molecular Biology	
Course Outcomes:		
The successful students will be able to:		
• Understand the structure of nucleic acids and their types. • Understand key events of Molecular biology comprising mechanism of DNA replication, transcription and translation in Prokaryotes and Eukaryotes. • Learn about the genomes and gene structure.		

Credits: 4		Discipline Specific Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours (60)
1	Nucleic acids as genetic material (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment), Structure and functions of Nucleic acids. Genome and its organization: (genes, coding sequence, regulatory sequence, intron, exon, nucleosome structure and packaging of DNA into higher order structures).	15
2	DNA replication, genetic code, principles of gene regulation, negative and positive regulation, concept of lac and trp operons, and regulation of gene expression. Damage and repair of DNA: Causes (spontaneous, chemical agent, radiation) and types of DNA damage and mechanism of DNA repair.	15
3	Genomes and gene structure: gene families, transcriptomics,	15

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	proteomics and biological databases. Genome sequencing techniques and applications: Sequencing strategies, the shotgun method, massively parallel sequencing and its applications, and next-generation sequencers. Cloning: Cloning vectors, c-DNA synthesis and cloning, genomic DNA and c-DNA libraries, Enzymes used in recombinant DNA techniques, and molecular markers, brief idea of CRISPR-Cas, Polymerase Chain Reaction, Electrophoresis, DNA fingerprinting and blotting techniques.	
4	Introduction to biological databases (NCBI, EMBL, DDBJ, UniProt): searching for gene/protein sequences and Basic BLAST analysis to find sequence similarity. Demonstration of PCR (Polymerase Chain Reaction) and Agarose gel electrophoresis—loading, running, and analyzing DNA.	15

Suggested Readings

- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York, USA.
- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). Molecular Biology of the Cell. Garland Publishing Inc., New York. 6th edition.
- Watson, J.D. (2013). Molecular Biology of the Genes, Benjamin. 7th Edition.
- Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
- Lewin, B. (2000). Genes VII. Oxford University Press, New York.
- Wolfe, S.L. (1993). Molecular and Cellular Biology. Wadsworth Publishing Co. California.
- Stent, G.S. (1986). Molecular genetics. Bishen Singh Mahendra Pal Singh, Dehradun.
- Barry, J.M. and Barry, B.M. (1973). Molecular Biology, Prentice Hall of India. New Delhi.

Saurabh

Semester VII

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Biotechnology	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY		
Programme: <i>Honours Degree in Botany</i>	Year: IV	Semester: VII
Subject: Botany		
Course: BOT DSE 5	Course Title: Plant Biotechnology	
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the process and techniques involved in bio-technology and plant tissue culture. 2. Analyze the tools and methodologies used in genetic engineering 3. Evaluate the methods and applications of recombinant DNA technology. 4. Understand the blotting techniques, DNA sequencing, and plant genetic engineering.		

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours(60)
1	Biotechnology: Principle and scope, bio-safety guidelines. Plant cell and tissue culture: Concept of cellular totipotency, principle of root and shoot generation <i>in vitro</i> , clonal propagation, applications of cell and tissue culture. Callus culture, organ culture, cell suspension culture, cryopreservation, protoplast culture, organogenesis, somatic embryogenesis, artificial seed, somatic hybridization, hybrids and cybrids, and somaclonal variation.	15
2	Recombinant DNA technology: Tools of genetic engineering, enzymes, cloning vectors (plasmids, cosmids, λ and phage, shuttle vectors, BACs, and YACs). Cloning strategies, Screening and selection of transformants.	15
3	Gene libraries (a general account): Genomic DNA libraries, cDNA libraries. Hybridization-colony hybridization, Southern hybridization, Northern hybridization, Western hybridization, DNA sequencing techniques: Maxam and Gilbert sequencing, Sanger sequencing. Genetic Engineering of plants: Aims, transformation techniques (<i>Agrobacterium</i> mediated transformation, electroporation, microinjection, and biolistics), strategies for development of transgenic plants with suitable examples (Golden rice, flavr-savr tomato, Bt cotton, moon dust carnations). Biosafety of transgenic plants.	15
4	Micropipetting Techniques (Learn accurate pipetting techniques). Preparation of Solutions and Buffers (Prepare standard solutions and buffers used in biotechnology labs). DNA Extraction (Extract and purify DNA from biological samples). Polymerase Chain Reaction (PCR) (Amplify specific DNA sequences).	15

Suggested readings

- Brown, T.A. (2018). Genomes 4. John Wiley and Sons (Asia) Pvt. Ltd. Singapore.
- Chrispeels, M.J. and Gepts, P. (2017). Plants, Genes and Agriculture. Oxford University Press.

Sanaibh

- Rai, A. C. (2009). Plant Biotechnology Laboratory Manual. I.K. International Publishing House. (A comprehensive manual offering a wide range of plant biotechnology experiments).
- Jolles, O. and Jornvall, H. (2000). Proteomics in Function Genomics. Birkhauser. Verlag, Basel, Switzerland.
- Shantharam, S. and Montgomery, J. F. (1999). Biotechnology, Biosafety and Biodiversity. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Collins, H. A. and Edwards, S. (1998). Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
- Callow, J. A., Ford-Lloyd, B. V. and Newbury, H. J. (1997). Biotechnology and Plant Genetic Resources: Conservation and Use. Cab International, Oxon, UK.
- Jain, S. M., Sopory, S. K. and Veilleux, R. E. (1996). In Vitro Haploid Production in Higher Plants, Vols. 1-5., Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Glazer, A. N. and Nikaido, H. (1995). Microbial Biotechnology, W. H. Freeman and Company, New York, USA.
- Primrose, S. B. (1995). Principles of Genome Analysis. Blackwell Science Ltd, Oxford, UK.
- Vasil, I. K. and Thorpe, T. A. (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.
- Bhojwani, S. S. (1990). Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
- Kartha, K. K. (1985). Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton. Florida, USA.

Semester VII

DISCIPLINE SPECIFIC ELECTIVE (DSE) - AN INTRODUCTION TO MICROBIOLOGY

No. of Hours - 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Microbiology	4	4	0	0	Bachelor of Science in Botany	Nil

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BACHELORINBOTANYWITHHONOURS		
Programme: <i>BachelorofBotanyWithHonours</i>		Year:IV Semester: VII
Subject:Botany		
Course:BOT DSE 6	CourseTitle:AnIntroductiontoMicrobiology	
CourseOutcomes: Afterthecompletionofthecoursethestudentswillbeableto: 1. Understandtheoccurrence,generalcharacters,types,reproductionandlifecycleofthe majormicrobial groups and their role in food, clinical and industrial microbiology. 2. Evaluatetheclassificatoryapproachesandadvancesinbacterial,viralandlichen taxonomies. 3. Demonstrate proficiency in basic microbiological techniques, including microscopy, bacterialstaining,culturemethods,andbiochemicaltestsformicrobialidentification. 4. Explain the factors affecting microbial growth, including environmental conditions, nutritionalrequirements,andgrowthkinetics,andapplyprinciplesofmicrobialcontroland sterilization.		

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	General account of Microorganisms: History of microbiology, Golden Era of Microbiology, characteristic features of bacteria, General account of actinomycetes, classification of microorganism-five kingdom classification, Microbial growth-measurement of microbial growth, Batch, Fed-batch and continuous culture, endophytic microorganisms.	15
2	Morphology and structure of bacterial cells: Morphology of bacterial cells based on size, shape and arrangement, fine	15

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	structure of bacterial cells (of both Gram negative and Gram positive bacteria) capsule, cell wall, cell appendages (flagella, fimbriae, pili), Structure of plasma membrane, cytoplasmic inclusions- mesosomes, chlorosome. Ribosome- Site of protein synthesis, Microbial genetics- transformation, conjugation and transduction.	
3	Morphology and structure of viruses: History, morphology, fine structure, shape and classification of viruses. Mycophages and prions, Tobacco mosaic virus (TMV), T4 Bacteriophage and HIV- their fine structure, genome organization and multiplication, Bacteriophage therapy, Overview of Corona virus. Medical microbiology, Aquatic microbiology, Aeromicrobiology, Food microbiology, Soil Microbiology, Industrial microbiology, Geochemical microbiology.	15
4	Microscopy Techniques (Introduce students to basic microscopy techniques and observation of microorganisms). Bacterial Staining: Gram Staining (Differentiate between Gram-positive and Gram-negative bacteria). Microbial Identification: Biochemical Tests (Identify unknown bacterial species based on biochemical characteristics). Antimicrobial Sensitivity Test (Determine the susceptibility of bacteria to antibiotics).	15

Suggested readings

- Tortora, G.J., Funke, B.R. and Case C.L. (2021). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 13th edition.
- Madigan, Bender, Buckley, Sattley, Stahl. (2019). Brock Biology of Microorganisms. Pearson. 15th edition.
- Cappuccino, J.G., Welsh, J. (2019). Microbiology: Laboratory Manual. Pearson.
- Marjorie, Kelly. and Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw Hill New York, 5th edition.
- Kathleen Park, Talaro and Barry Chess. (2017). Foundations in Microbiology. McGraw Hill New York, 10th edition.
- Willey, Joanne, Sherwood, Linda., Woolverton, Christopher J. (2017). Prescott's Microbiology. McGraw Hill New York, 11th edition.

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- Cappuccino, J.G., Sherman, N. (2016). Microbiology: A Laboratory Manual. Pearson.
- Harley, J.P. (2013). Microbiology: Laboratory Exercises. McGraw-Hill Education.
- Mukherjee, K.G. and Singh V.P. (1997). Frontiers in Applied Microbiology. Rastogi Publ. Meerut.
- Power, C.B. and Dagainawala H.F. (1996). General Microbiology. Vol 2. Himalaya Pub. House, New Delhi.
- Kaushik, P. (1996). Introductory Microbiology. Emkay Publ, Delhi.
- Pelczar, M.J., Chan, ECS and Kreig, N.R. (1993). Microbiology. McGraw Hill, New York. Fifth Edition.
- Alexander, M. (1991). Microbial Ecology. John Wiley and Sons. New York.
- Doelle, H.W. and C.G. Heden (1986). Applied Microbiology, Kulwer Academic Press, London.
- Miller, B.M. and W. Litsky (1976). Industrial Microbiology. McGraw Hill New York.

Semester VII

No. of Hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE)- PLANT DEVELOPMENT AND REPRODUCTIVE BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Development and Reproductive Biology	4	4	0	0	Bachelor of Science in Botany	Nil

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Programme: <i>Bachelor in Botany With Honours</i>		Year: IV	Semester: VII
Subject: Botany			
Course: BOT DSE 7	Course Title: Plant Development and Reproductive Biology		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the morphological characteristics of flower. 2. Study the fundamental concepts of root, shoot and leaf development. 3. Understand various stages of plant development. 4. Understand the developmental biology of male and female gametophyte, pollen-pistil interaction. 5. Study the basic idea of embryogenesis and seed development process, apomixes and polyembryony.			

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Morphology: Morphology of flower, stamen and carpel, Floral characteristics, structure of the pistil, Pollen-stigma interactions, Plant adaptations—physiological and their morphological characteristics (xerophyte, hydrophyte and halophyte). Shoot development: Organization of the shoot apical meristem (SAM): control of cell division and tissue differentiation especially xylem and phloem: secretory ducts and laticifers. Leaf growth and differentiation, structural development and classification of stomata and trichomes.	15
2	Root Development: Organization of root apical meristem (RAM), vascular tissue differentiation, lateral root, root hairs,	

	ABCD model of flower, Florigen pathway. Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, pollen germination, pollen tube growth and guidance, pollen allergy. Female gametophyte: Ovule development, megasporogenesis, development and organization of the embryo sac, structure of the embryo sac cells.	15
3	Pollination: pollination mechanism and vectors. Pollen-pistil interaction and fertilization: pollination mechanism and vectors, sporophytic and gametophytic self-incompatibility, double fertilization. Seed development and fruit growth: Endosperm development during early maturation and desiccation stages: embryogenesis, cell lineages during late embryo development, polyembryony, apomixis. Latent life- dormancy: Importance and types of dormancy, seed dormancy, bud dormancy.	15
4	To study the androecium and gynoecium of different families. To study the type of inflorescence of different families. Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma), complex and secretory tissues. Anatomy of monocot and dicot stem; monocot and dicot leaf; monocot and dicot root. Adaptive anatomy: Xerophytes, Hydrophytes, Epiphytes Normal and abnormal secondary growth in different plants. To study the type of anthers and T.S. of the anther To study the pollen grains of different families. To study the types of placentation. To study the types of pollination and seed dispersal mechanisms (photographs and specimens)	15

Suggested readings

- Bhatnagar S.P, Dantu, P.K. Bhojwai S.S. (2018). The embryology of Angiosperms. Vikas Publ. House. New Delhi.
- Lalit M. Srivastava. (2002). Plant Growth and Development. Hormones and

Environment. Academic Press. 1st Edition.

- Raghavan V. (1999). Developmental biology of flowering plants. Springer Verlag. New York.
- Howell, S.H. (1998). Molecular genetics of plant Development. Cambridge Univ. Press.
- Fonkot, De. (1994). Plant growth and Development. A molecular approach. Academic Press. San Diego.
- Lyndon. R.F. (1990). Plant Development. The Cellular Basis. Unwin Hyman. London.

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE (DSE)-CYTOGENETICS

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Cytogenetics	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: Bachelor in Botany With Honours		Year: IV	Semester: VIII
Subject: Botany			
Course: BOT DSE 8	Course Title: Cytogenetics		

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Course Outcomes:

After the completion of the course the students will be able to:

1. Apply the concepts of Mendelian genetics to solve problems on linkage, crossing over and gene mapping.
2. Analyze human pedigree and apply the principles of population genetics to work out problems on genotype frequency and Hardy-Weinberg equilibrium.
Understand the Chromosomal aberrations and their role in genome evolution with special reference to crop plants.
3. Understand modern breeding methods in improving agricultural crop varieties.
4. Understand the process of cell cycle its regulation and the mechanism of apoptosis.

Credits:4	Discipline Specific Elective
Max.Marks: As per Univ.rules	Min.Passing Marks: As per Univ.rules

Unit	Topic	No.of Hours (60)
1	Mendelian principles: Dominance, Segregation, independent assortment; extension of Mendelian principles (co dominance, incomplete dominance, gene interactions, pleiotropy); linkage and crossing over, sex linked, sex limited and sex influenced characters. Genetic recombination and gene mapping: Recombination, role of RecA and RecB, C, D enzymes, gene mapping methods (linkage maps, tetrad analysis, mapping with molecular markers); population genetics - gene pool, gene frequency, Hardy-Weinberg law.	15
2	Structural and numerical alterations in chromosome: Origin, meiotic behaviour and consequences of duplication, deletion, inversion and translocation. Mutation: spontaneous and induced mutation; physical and chemical mutagens; molecular basis of mutation; DNA damage and repair mechanisms; transposable elements, mutations induced by transposons; cell cycle and apoptosis, cancer at cellular level.	15
3	Chromosome structure: Packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes; euchromatin and heterochromatin;	15

	NuclearDNAcontent,C-valueparadox;Cot-curvesandtheir significance Genestructureandexpression:geneticfinestructure;cis-transtest; introns andexons; RNA splicing multiple alleles, pseudoallele, regulation of gene expression in prokaryotesand eukaryotes.	
4	To study Mendelian and Non- Mendelian gene interaction ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) through seeds. EvaluatethegenetichypothesisemployingtheChisquaretest To observe the various stages of mitosis and meiosis with the help of onion root tip and bud respectively.	15

Suggestedreadings

- Lodish, H., Berk, A., Zipursky, S.L. Maztsudaira, P., Baltimore, Dand Darnell, I. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York,USA.
- Alberts,B.,Bray,D.,Lewis,J.,Raff,M.,Roberts,K.andWatson,J.D.(2014). MolecularBiologyoftheCell.GarlandPublishingInc.,NewYork.6thedition.
- Watson,J.D.(2013).MolecularBiologyoftheGenes,Banjamin.7thEdition.
- Buchanan,B.B.,Gruissem, W. and Jones, R.L. (2000). Biochemistry andMolecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
- Lewin,B.(2000).GenesVII.OxfordUniversityPress,NewYork.
- Atherly,A.G.,Girton,J.R.andMcDonald,J.F.(1999).TheScienceofGenetics. SaundersCollegePublishing,FortWorth,USA.
- Gupta,P.K.(1998).Cytogenetics.RastogiPublications,Meerut. Hartl, D.L. and Jones, E.W. (1998). Genetics: Principles and Analysis (4nd Edition). Jones and Bartlett Publishers, Massachusetts, USA.
- Malacinskim G.M.D. and Freifelder, D. (1998). Essentials of Molecular Biology (3rdEdition). Jones and Bartlett Publishers, Inc. London.
- Kleinsmith,L.J.and Kish,V.M.(1995).Principlesof CellandMolecularBiology(2nd Edition).HarperCollinsCollegePublishers,NewYork,USA.
- Wolfe, S.L. (1993).Molecular and Cellular Biology. Wadsworth Publishing Co.California.

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Semester VIII

DISCIPLINE SPECIFIC ELECTIVE (DSE)- ECOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Ecology	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

BACHELORINBOTANYWITHHONOURS		
Programme: <i>BachelorinBotanywithHonours</i>	Year: IV	Semester: VIII
Subject:Botany		
Course:BOT DSE 9	CourseTitle:Ecology	
CourseOutcomes: Afterthecompletionofthecoursethestudentswillbeableto: 1. Understandthescopeandconceptsofecologyanddiscussthebiosphere, biomesand biogeography. 2. Analyzetheprocessofecologicalsuccession. 3. Evaluatetheimportanceofthemajorworldecosystems. 4. Distinguishbetweenspecies, populations, communities, ecosystemandbiomes.		

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Major terrestrial biomes; Zonoeotones, Orobionomes and Pedobionomes, Freshwater aquatic ecosystems; Marine ecosystems. Community structure and attributes; Edges and ecotones; Keystone species and control of community structure. Types of species interactions, herbivory, carnivory, pollination, symbiosis (obligate and facultative symbiosis).	15
2	Population Ecology: Characteristics of population; population growth curves; population regulation life history strategies (r and K selection); population genetics and natural selection. Habitat and niche: Concept of habitat and niche; niche width and overlap, fundamental and realized niche. Biodiversity: Levels of Biodiversity, Uses of biodiversity; Biodiversity, ecosystem services and functions. Distribution of biodiversity; Gradients of biodiversity; Hotspots; Threats to biodiversity, Key stone species. Extinction of species: Biodiversity assessment and inventory; Conservation of biodiversity; Indices; Biodiversity and its conservation; International efforts for conserving biodiversity. Climate change and conservation: Greenhouse gases; sources, trends and role; ozone layer and ozone hole; Consequences of climate change; Principles of conservation.	15
3	Ecological succession: Causes, mechanism and types, changes involved in succession; Concept of climax. Ecosystem: Structure and functions; energy dynamics (Tropical organization, energy flow pathways, ecological efficiencies); litter fall and decomposition (mechanism, substrate quality and climatic factors); Global biogeochemical cycles of C, N, P and S (pathways, processes in terrestrial and aquatic ecosystems); nutrient use efficiency; Global hydrological cycle.	15
4	Vegetation analysis for Community Structure: Quadrat Method, Importance Value Index (IVI), Distribution pattern, Shannon Index (Shannon and Weiner Index), Simpson's index (Concentration of dominance). Population Structure and Regeneration Status, Estimation of Plant Biomass. Estimation of Net Primary Productivity, Forest Floor Biomass, Measurement of leaf area.	15





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Suggested readings

- Kormondy, E.J. (2017). Concept of Ecology. Pearson India.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Baskin and Baskin, (2001). Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination Elsevier.
- Smith, R.L. (1996). Ecology and Field Biology Harper Collins, New York
Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California
- Odum, E.P. (1983). Basic Ecology Saunders, Philadelphia.

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE (DSE)-PLANT SYSTEM PHYSIOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant System Physiology	04	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: Bachelor in Botany with Honours	Year: IV	Semester: VIII
Subject: Botany		

Course: BOT DSE 10	Course Title: Plant System Physiology
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the mechanism of transport and translocation of water and analyze the mechanisms of acclimation and adaptation of plants to stress conditions. 2. Understand the process of transpiration, photosynthesis and respiration and analyze these processes in various groups of plants. 3. Gain awareness on the nitrogen cycle and the role of microbes and plants in the nitrogen cycle. 4. Understand the role of plant growth regulators and photoreceptors in plant growth and development. 5. Demonstrate the ability to measure the rate of photosynthesis using various techniques and interpret the results in relation to light intensity and other environmental factors. 6. Perform chlorophyll extraction and use spectrophotometry to quantify chlorophyll a and b in plant tissues, understanding their role in photosynthesis and plant health. 7. Design and conduct experiments to study the effects of various environmental factors, including light and temperature, on seed germination and seedling development.	

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Membrane transport and translocation of water and solutes: Plant – water relations, mechanism of water transport through xylem, phloem loading and unloading, passive and active solute transport, membrane transport of proteins. Signal transduction and sensory photobiology: Receptors, phospholipids signaling, phytochromes and cryptochromes.	15

2	Photosynthesis: General concepts and historical background, steps of photosynthesis, Emerson's effect, two pigment systems, Calvin cycle, photorespiration and its significance. C₄ cycle, CAM pathway Respiration: Glycolysis, TCA cycle, electron transport chain and ATP synthesis, pentose- phosphate pathway, glyoxylate cycle. Nitrogen fixation and metabolism: Biological nitrogen fixation, mechanism of nitrate uptake and reduction, ammonia assimilation.	15
3	Plant growth regulators: Physiological effects and mechanism of auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines, jasmonic acid, Hormone receptors and vitamins, phytochrome and cryptochrome. Photoperiodism and vernalization and their significance; Floral induction and development Plant movements. Stress physiology: Plant responses to biotic and abiotic stresses, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, freezing and heat stress, oxidative stress.	15
4	To measure the rate of photosynthesis in aquatic plants using the floating leaf disk assay. To determine the stomatal density on the leaves of different plant species. To measure the rate of transpiration in plants using a potometer. Measure the rate of respiration in plant tissues. To extract and quantify chlorophyll from plant leaves using spectrophotometry.	15

Suggested readings

- Taiz, L; Zeiger, E; Moller, I. M. and Murphy A. (2023). Plant Physiology and Development. Publisher: Sinauer Associates print of Oxford University Press. 6th Edition.
- Huner, N.P.A, and Hopkins, W.G. (2008). Introduction to Plant Physiology. Wiley 4th Edition.
- Devi, P. (2000). Principles and methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios.
- Buchanan, B.B, Gruissem W. and Jones, R.L. (1996). Biochemistry and Molecular Biology of plants by Enzymes: A practical introduction to structure, mechanism and data analysis. R.A. Copeland.
- Scott, R.P. W. (1995). Techniques and Practice of Chromatography. Taylor and Francis, Routledge.

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Semester IX

DISCIPLINE SPECIFIC ELECTIVE (DSE) – EVOLUTIONARY BIOLOGY OF PLANTS

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Evolutionary Biology of Plants	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: Bachelor in Botany With Honours

Year: V

Semester: IX

Subject: Botany

Course: BOT
DSE 11

Course Title: Evolutionary Biology of Plants

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the essential theories of evolution
2. Differentiate between micro and macro evolution and the forces shaping evolution
3. Construct phylogenetic trees based on morphological and molecular data
4. Understand the evolution of life and different groups of plants.

Credits: 4

Discipline Specific Elective

Max. Marks: As per Univ. rules

Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Historical Perspective of evolutionary concepts: Pre-Darwinian ideas, Lamarckism, Darwinism, Post-Darwinian era – Modern synthetic theory, Neo-Darwinism, Pre-biotic conditions and events; Evolution of eukaryotes from prokaryotes.	15
2	Evidences of Evolution: Paleobiological– Concept of Stratigraphy and geological timescale; fossil study, Taxonomic –Transitional forms/evolutionary intermediates, living fossils. Microevolution and Macroevolution: Hardy Weinberg equilibrium; Founder effect, Natural and artificial selection. Levels of selection. Gene trees, species trees; Patterns of evolutionary change, Mutation, Gene flow, Selection, Genetic Drift, Co-evolution.	15
3	Evolution of Land Plants: Species concept, Modes of speciation – Allopatric; sympatric; peripatric; Origin of land plants – Terrestrial algae and bryophytes; Early vascular plants – Stelar evolution; seed habit and evolution of seed, adaptive strategies of different group of plants.	15
4	Study of Lamarckism, Darwinism, and Neo-Darwinism through the (Specimens/slides/photographs) various examples. Study of different types of fossils, connecting links/transitional forms and Living fossils (Specimens/slides/photographs) To study the various evolutionary events in geological timescale through the (specimens/slides/photographs). Sampling of quantitative characters (continuous and discontinuous) in a population (height, weight, number of nodes etc).	15

Suggested readings

- Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
- Ridley, M. (2004). Evolution. III Edn. Blackwell Pub., Oxford.
- Hall, B.K., Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett.
- Zimmer, C., Emlen, D.J. (2013). Evolution: Making Sense of Life. Roberts & Co.
- Futuyma, D. (1998). Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
- Barton, Briggs, Eisen, Goldstein and Patel. (2007). Evolution. Cold Spring Harbor Laboratory Press.
- k, M. (2017). Evolution, 4th Ed. Sinauer, Sunderland, MA: Sinauer Associates.

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Semester IX

DISCIPLINE SPECIFIC COURSE (DSE) – PLANT PATHOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Pathology	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY

MASTER OF SCIENCE IN BOTANY			
Programme: <i>Master of Science in Botany</i>		Year: V	Semester: IX
Subject: Botany			
Course: BOT DSE 12	Course Title: Plant Pathology		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the general characteristics of plant pathogenic organisms including fungi, bacteria, viruses and mycoplasma. 2. Study the interactions between plant and pathogen in relation to the environment and mechanism of disease development by pathogens. 3. Understand the genetics of host-parasite interaction. 4. Understand the various enzymes and toxins involved in disease development. 5. Study various important plant diseases, their disease cycle and control measures.			

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Credits:4	Discipline Specific Elective
Max.Marks: Asper Univ.rules	Min.Passing Marks:Asper Univ. rules

Unit	Topic	No. of Hours (60)
1	A brief history of plant pathology in India Types of pathogens, symptoms of different plant diseases. Inoculum: Inoculum types, theory of inoculums, survival and longevity of inoculums, inoculums production, potential and density. Plant microbe interaction: molecular basis of host recognition, pathogenesis: pre-penetration, penetration and post penetration events, factors affecting disease development (host factors, environmental factors, virulence susceptibility). Dissemination of pathogens: Means of dissemination (active and passive dissemination). Genetics and host parasite interaction: Concept of compatibility and specificity, gene for gene relationship, genetics of resistance, source of resistance, inheritance of resistance in the host. Enzymes and toxins: Enzymes involved in disease development, toxins and their role in plant health.	15
2	Disease resistance: (i) Protection (structural, chemical, absence of nutrients and common antigens). Defense (histological defense, chemical-polyphenols, prohibitins, inhibitions, phytoalexins, lectins). Genetic resistance: resistant genes, biotechnological approaches for transfer of R-genes into susceptible plant. Seed pathology: Seed borne pathogens, mechanism of seed infections in field and during storage, transmission of pathogens through seeds, seed health testing methods, market disease of fruits and vegetables. Disease control: Cultural practices, chemical methods (insecticides, systemic and non-systemic chemical), biological control: Introduction, Biological control of insects and pests, use of resistance varieties and plant quarantine.	15
3	Brief account, structure, importance, disease cycle and control of the following diseases: (i) Damping-off, (ii) Wilt, (iii) Root rot, stem rot and fruit rot (iv) Mildews (powdery and downy), (v) Rusts, smuts, (vi) Leaf	15

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	spots and leaf blights. General characteristics, importance, disease cycle and control of the following: (i) Bacterial disease, (ii) Viral disease, (iii) Mycoplasma disease.	
4	Study of various instruments used in Plant Pathology laboratory. Media preparation, isolation and culturing of plant pathogens Study of various fungal, bacterial and viral diseases - symptoms with the help of live or preserved specimens /digital resources. Study of causal organism with the help of temporary tease/section mounts.	15

Suggested readings

- Mehrotra, R.S. (2013). Plant Pathology. Tata McGraw Hill Publishing Co Ltd. New Delhi.
- Agrios, G.N. (2011). Plant Pathology. Elsevier.
- Bouarab, N. K., N. Bissow and F. Daayf. (2009). Molecular Plant Microbe Interactions.
- Mehrotra, R.S. and Agrawal, A. (2003). Plant Pathology. Tata McGraw Hill Publishing Co Ltd. New Delhi.
- Lucas, J.A. (1988). Plant Pathology and Plant Pathogens. Third edition. Blackwell.
- Singh, R.S. (1988). "Plant diseases". Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Singh R.S. (2018). Plant Diseases. 10th Edition Medtech, New Delhi.
- Sharma, P.D. (2014). Plant Pathology. Rastogi Publications, Meerut.

Semester IX

DISCIPLINE SPECIFIC COURSE (DSE) – Protected Agriculture – Hydroponics and Organic Cultivation

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Protected Agriculture: Hydroponics and Organic Cultivation	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY

Programme: Master of Science in Botany

Year: V

Semester: IX

Subject: Botany

Course: BOT DSE 13

Course Title: Protected Agriculture: Hydroponics and Organic Cultivation

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand various aspects of hydroponics, aquaponics and organic cultivation.
2. Become economically self-reliant by growing and marketing organic herbs, vegetables, microgreens and fruits.
3. Gain practical training in establishing a hydroponic facility.
4. Understand good agricultural practices associated with protected agriculture.

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules





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Unit	Topic	No. of Hours (60)
1	Introduction to protected agriculture: Types of protected agriculture (hydroponics, aquaponics and organic farming), definition, history, terminology, importance and advantages over traditional agriculture, limitations and challenges.	15
2	Plant growth requirements : Physical parameters - light (quality and quantity) artificial light, light balancers; pH, conductivity, salinity (Dissolved Oxygen-DO, Total Dissolved Solid - TDS) and temperature; Chemical parameters- mineral nutrient requirements, deficiencies, toxicities, growth regulators (auxins, gibberellins, cytokinins and abscisic acids); Growth media- types, properties, uses, nutrient formula and preparation of solutions.	15
3	Hydroponic growing systems: Basic concepts and designs (closed and open systems techniques, Nutrient Film Technique (NFT), Deep Water Culture (DWC), Dutch Bucket and other small-scale systems), systems layout. Strengths and weaknesses of various systems, site considerations, components and methods for nutrient delivery. Organic farming and its management: Organic farming and associated management practices. Marketing of the organic produce. Government institutes and policies related to protected farming. Pest and disease management.	15
4	Study of various instruments used in hydroponics. Preparation of growth media for hydroponics. Estimation of NPK, DO, TDS, pH of growing media. Demonstration of different irrigation techniques in hydroponics	15

Suggested readings

- Hasan, M., Sabir, N., Singh, A.K., Singh, M.C., Patel, N., Khanna, M., Rai, T., Pragnya, P. (2018). Hydroponics Technology for Horticultural Crops, Tech. Bull. TB-ICN 188/2018. Publ. by I.A.R.I., New Delhi-110012 INDIA.
- Misra S., Misra S., Misra R.L. (2017). Soilless Crop production. Daya Publishing House, Astral International (P) Ltd., New Delhi.
- Palaniappan S. P., Annadurai K. (2018). Organic Farming: Theory & Practice. Scientific Publisher. 5. Goddek, S., Joyce, A., Kotzen, B., Burnell, G.M. (2019). Aquaponics Food Production Systems. Springer, Cham.
- Jones, J.B. (2014). Complete Guide for Growing Plants Hydroponically. CRC Press.
- Vayas, S.C., Vayas, S., Modi, H.A. (1998). Bio-fertilizers and organic Farming. Akta Prakashan, Nadiad.

Semester X

DISCIPLINE SPECIFIC ELECTIVE (DSE) – BIOINFORMATICS AND BIOSAFETY NORMS

No. of Hours-60

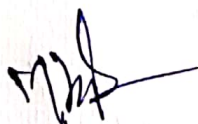
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Bioinformatics and Bio-safety Norms	4	4	0	0	Honours Degree in Botany	Nil

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MASTER OF SCIENCE IN BOTANY		
Programme: <i>Master of Science in Botany</i>	Year: V	Semester: X
Subject: Botany		
Course: BOT DSE 14	Course Title: Bioinformatics and Biosafety Norms	
Course outcomes: After the completion of the course the students will be able to		
1. Understand the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field. 2. Learn about biological databases, sequence retrieval, alignment, and phylogenetic analysis using various tools. 3. Understand the basic concept of Intellectual Property rights		

Credits: 4		Discipline Specific Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours (60)
1	Introduction to Bioinformatics Historical background; Aims and scope; Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology. Role of bioinformatics in drug discovery; Applications and Limitations of bioinformatics.	15
2	Biological databases Introduction to biological databases - Primary, secondary and composite databases; Study of following databases: NCBI (GenBank, PubChem, PubMed and BLAST; introduction to EMBL, DDBJ, UniProt, PDB and KEGG.	15
3	Basic concepts of Intellectual Property Rights (IPRs). The implications of the Intellectual Property Rights on the Convention on Biological Diversity (CBD).	15


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4	Biological databases (NCBI, EMBL, UniProt, PDB) Literature retrieval from PubMed. Protein Structure retrieval from PDB (in pdb format) and visualisation by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol).	15
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Suggested readings

- Ghosh, Z., Mallick, B. (2008). Bioinformatics – Principles and Applications, 1st edition. New Delhi, Delhi: Oxford University Press.
- Baxevanis, A.D., Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
- Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
- Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
- Paroda, R.S. & R.K. Arora (1991). Plant Genetics Resources Conservation and Management concepts and approaches. New Delhi.
- Krattigar, F. Anatole. et al. (1994 Ed.) Widening Perspectives on Biodiversity. Dehradun.
- Yamin, F. (1995) The Biodiversity Conservation and Intellectual Property Rights. Switzerland.

Semester X

DISCIPLINE SPECIFIC ELECTIVE (DSE) – ADVANCES IN PLANT TAXONOMY

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Advances in Plant Taxonomy	4	4	0	0	Honours Degree in Botany	Nil

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MASTER OF SCIENCE IN BOTANY		
Programme: <i>Master of Science in Botany</i>	Year: V	Semester: X
Subject: Botany		
Course: BOT DSE 15	Course Title: <i>Advances in Plant Taxonomy</i>	
Course outcomes: After the completion of the course the students will be able to		
1. Understand the naming of the plant through plant nomenclature. 2. Learn the phylogeny and classification of angiosperms of system their use and utility. 3. Identify various angiosperm families with specific key characters. 4. Learn various advanced tools used to study plant taxonomy. 5. Understand the latest molecular techniques used in plant taxonomy. 6. Explore the impact of bioinformatics on plant classification. 7. Study the role of phylogenetic analysis in plant taxonomy.		

Credits: 4		Discipline Specific Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours (60)
1	History of different systems of classification (introduction only). Important systems- Bentham and Hooker, Hutchinson, A. Takhtajan, A. Cronquist, Robert Thorne, Angiosperm Phylogeny Group (APG IV) classification. A brief account of major contributions made by the following taxonomists: C. Linnaeus, J.D. Hooker, William Roxburgh and Duthie., International Code of Nomenclature (ICN) for Algae, Fungi, and Plants.	15
2	Taxonomic tools, histological, cytological, phytochemical, serological, biochemical, and molecular techniques. Relevance of taxonomy to conservation. Modern techniques in plant taxonomy including: molecular phylogenetic, DNA Bar Coding, DNA extraction, amplification, sequencing and Digital herbarium database (Access Digital Herbarium DataBase) Search for records of your plant species and related taxa.	15

	Compare your specimens with digital records. Use of Electrophoresis, PCR, HPLC and other instruments useful in molecular taxonomy, Operational Taxonomic Unit (OTU) and OTU Clustering.	
3	Some important families: Magnoliaceae, Myrtaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Amaranthaceae, Cannabaceae, Moraceae, Orchidaceae, Zingiberaceae, Cyperaceae, Poaceae. Update the plant nomenclature with different website (Plants of the World Online (PWO) Kew Science, Global Biodiversity Information Facility (GBIF) International Plant Nomenclature Index (IPNI), Tropicos), e-flora.	15
4	To study the vegetation type(s) and flora(s) of different areas in the local areas, and training in collection and preservation. To study the molecular techniques used in plant taxonomy. To study the advanced tools used in plant taxonomy	15

Suggested readings

- Kochhar S.L. (2016). Economic Botany. Cambridge University Press, London.
- Angiosperm Phylogeny Group (APG-2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1-20.
- Saxena, N.B. and Saxena, S. (2012). Plant Taxonomy. Pragati Prakashan.
- Sambamurthy A.V.S.S. (2010). Taxonomy of Angiosperms. I.K. International Pvt. Ltd.
- Singh, G. (2010). Plant Systematics. CBS PUB & DIST PVT Limited INDIA.
- Sharma, O.P. (2009). Plant Taxonomy. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Gaur R.D. (1999). Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.
- Bhattacharya B. and B.M. Joshi. (1998). Flowering plants. Taxonomy and phylogeny Norsa publishing house New Delhi.

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- Heywood V.H. and D.M. Moore. (1984). Current concept in plant taxonomy. Systematics special volume 25. London.
- Davis P.H. and Heywood V.H. (1973). Principles of angiosperm taxonomy. Robert E. Kreigh Pub. Co. New York.
- Heywood V.H. (1970). Plant taxonomy London.
- Bensen L. (1957). Plant Classification reprint. Oxford & IBHN. Delhi.
- Lawrence G.H.M. (1951). Taxonomy of vascular plants. MacMillan N. York.

Semester X

DISCIPLINE SPECIFIC ELECTIVE (DSE) - PLANT BREEDING

No. of Hours - 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Breeding	04	4	0	0	Bachelor of Science in Botany	Nil

MASTERS OF SCIENCE IN BOTANY		
Programme: <i>Masters of science in Botany</i>		Year: V Semester: X
Subject: Botany		
Course: BOT DSE 16	Course Title: Plant Breeding	

Course Outcomes:

After the completion of the course the students will be able to:

Understand the principles of plant breeding, including its important achievements and undesirable consequences of plant breeding.

Understand the process of hybridization, advantages and limitations.

Understand the plant breeding systems and heterosis and role of mutation in plant breeding.

Credits:4	Discipline Specific Elective
Max.Marks: As per Univ.rules	Min.Passing Marks: As per Univ. rules

Unit	Topic	No.of Hours (60)
1	Plant breeding: Introduction and objectives; breeding systems, important achievements and undesirable consequences of plant breeding; methods of crop improvement; Centres of origin and domestication of crop plants, plant genetic resources, acclimatization; selection methods	15
2	Hybridization: Hybridization technique for self-pollinated and cross-pollinated crops. Vegetatively propagated plants—procedure, advantages and limitations; Inbreeding depression and heterosis (history, genetic basis and applications). Crop improvement and breeding (role of mutations; polyploidy; distant hybridization and biotechnology in crop improvement).	15
3	Effects of aneuploidy on plant phenotypes; Transmission of monosomics and trisomics and their uses, Chromosome mapping of diploid and polyploidy species, evolution of major crop plants (wheat and rice).	15
4	Introduction to plant breeding techniques: handling and maintenance of breeding populations, Study of pollination mechanisms in self-pollinated and cross-pollinated crops, Selection methods: Demonstration of pure-line selection and mass selection methods. Study of polyploidy and its effects on plant morphology using prepared slides/specimens, Chromosome analysis: Karyotyping and chromosome mapping in diploid and polyploid species.	15

Suggested readings

- Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991). Principles of Genetics, John Wiley & Sons.
- Allard, R.W. (1999). Principles of Plant Breeding. John Wiley & Sons.
- Rastogi, V.B. (2019). Genetics. 4th Edition. MEDTECH: A Division of Scientific International.
- Russell P.J. (2010). Genetics - A Molecular Approach, Pearson Education Inc.
- Singh R.J. (2002). Plant Cytogenetics, CRC Press.
- Singh, B.D. (2005). Plant Breeding: Principles and Methods (7th Edition). Kalyani Publishers.
- Strickberger M.W. (2008). Genetics, Pearson (Prentice Hall).
- Acquah, G. (2012). Principles of Plant Genetics and Breeding. Wiley-Blackwell.
- Watson, J.D. (2013). Molecular Biology of the Genes, Benjamin. 7th Edition.

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Semester-I

Undergraduate Certificate in Botany

GENERIC ELECTIVE (GE)-Plant Cell Biology

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Cell Biology	4	4	0	0	Passed Class XII	Nil

UNDERGRADUATE CERTIFICATE IN BOTANY

Programme: Undergraduate Certificate in Botany		Year: I	Semester: I
Subject: Botany			
Course: BOT GE 1	Plant Cell Biology		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the plant cell structure and its function. 2. Understand the various cell components and the general principles in cell communication and interaction. 3. Study the structure and genome organization of chloroplast and mitochondria.			

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No.of Hours (60)
1	Principles of microscopy, cell theory, structural organization of the plant cell and its chemical composition, Cell wall structure and function.	15
2	Plasma membrane, models, structures and functions, Cytoskeleton, organization and role of microtubules and microfilaments.	15
3	Structure and functions of nucleus, endoplasmic reticulum, golgi apparatus, ribosomes, lysosomes and glyoxysomes, chloroplast and mitochondria.	20
4	Demonstration of types of cells and different cell organelles through slides/photographs .	10

Suggested Readings

- Alberts, B., Hopkin, K., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2019). Essential cell biology (5th ed.). W. W. Norton & Company, Inc.
- Rastogi, V. B. Cell Biology. Medtech Science Press: A Division of Scientific International.
- Verma, P. S. and Agrawal, V. K.. Cell Biology. (2016) S. Chand and Company, New Delhi.

Semester-II

Undergraduate Certificate in Botany

GENERIC ELECTIVE (GE)-Plant Science-I

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Science - I	4	4	0	0	Passed Class	Nil

UNDERGRADUATE CERTIFICATE IN BOTANY

UNDERGRADUATE CERTIFICATE IN BOTANY		
Programme: Undergraduate Certificate in Botany	Year: I	Semester: II
Subject: Botany		
Course: BOT GE 2	Plant Science-I	
Course Outcomes: After the completion of the course the students will be able to: 1. Develop understanding about the classification and diversity of different microbes (viruses, Algae, Fungi & Lichens) and their economic and ecological importance. 2. Understand the structure and reproduction of certain selected bacteria, algae, fungi and lichens. 3. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms. 4. Understand the basic concepts of plant taxonomy. 5. Understand plant morphology, anatomy and embryology.		

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Microbes: General characteristics, economic and ecological importance of bacteria and viruses. Algae: General characteristics; range of thallus, reproduction and economic importance Fungi: General characteristics, reproduction, ecology and significance.	15
2	Bryophytes: General characteristics, reproduction and economic importance. Pteridophytes: General characteristics, ecological and economic importance. Gymnosperms: General characteristics, ecological and economic importance. Introduction to Plant taxonomy, ICN, Herbarium and botanical garden.	20
3	Plant Embryology: Embryo, types of ovules and embryo sacs; endosperm; types of endosperm; dicot and monocot embryo, pollination, fertilization. Plant Anatomy: Types of tissues, root and shoot apical meristems, simple, complex and secretory tissues, structure of dicot and monocot root, stem and leaf.	15
4	Demonstration of representative specimens of each group. Demonstration of types of embryo, ovules and cells through slides/photographs.	10

Suggested Readings

- Alexopoulos, C.J., Mims, C. W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, John Wiley and Sons (Asia).
- Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East- West. Press Pvt. Ltd.
- Bhatnagar, S.P., Moitra, A. (1996). Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd Publishers.
- Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Prayagraj: U.P.: Central Book Depot.

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- Tortora, G.J., Funke, B.R., Case, C.L. (2007). Microbiology. San Francisco, U.S.A: Pearson Benjamin Cummings.
- Raven, P.H., Evert, R.F., Eichhorn, S.E. (1999). Biology of Plants. New York, NY: W.H. Freeman and Company Worth Publishers.
- Singh, G. (2012). Plant Systematics: Theory and Practice, 3rd edition. Oxford and IBH Pvt. Ltd. New Delhi.

Semester-III

Undergraduate Diploma in Botany

No. of Hours - 60

Generic Elective: Plant Science-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Science - II	4	4	0	0	Passed Class	Nil

UNDERGRADUATE DIPLOMA IN BOTANY

UNDERGRADUATEDIPLOMAINBOTANY		
Programme:UndergraduateDiplomainBotany	Year:II	Semester: III
Subject:Botany		
Course:BOT GE 3	PlantScience–II	
CourseOutcomes:		
Afterthecompletionofthecoursethestudentswillbeableto		
1. Understandthebasicbiochemicalandphysiologicalprocessinplants.		
2. Understandthefundamentalsofplanttissueculturetechniquesusedinmolecularbiology.		
3. Understandtheconceptofbiodiversityanditsconservation.		
4. Understandtheconceptsofplantbreedingmethodsandcropevolution.		

Credits:4	Generic Elective
Max.Marks:Asper Univ. rules	Min.Passing Marks:Asper Univ.rules

Unit	Topic	No.of Hours (60)
1	Plant Physiology and Biochemistry: Photosynthesis, respiration, nitrogen fixation, carbohydrates, proteins, lipids and secondary metabolites.	15
2	Plant Biotechnology: Plant tissue culture, recombinant DNA technology and techniques used in molecular biology. Plant breeding methods and evolution of major crop plants, economics and utilization of plant resources.	15
3	Biodiversity and Conservation: Species, population, ecosystem, ecological succession, environmental pollution, biodiversity, In situ and ex situ conservation, International Union for Conservation of Nature (IUCN), Climate change and its consequence.	15
4	To test the presence of protein, carbohydrate and lipids in given sample. Preparation of MS medium for tissue culture. Visit to some in-situ and ex-situ conservation sites.	15

Suggested Readings

- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
- Frankel O.H, Brown A.D.H. and Burdon J.J. (1995). The Conservation by Plant Diversity Technical guidelines for the site movement of Germplasm (1989) by FAO IBPGR.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition.
- Kochhar S.L. (2016). Economic Botany. Cambridge University Press, London.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.
- Paroda R.S. and Arora R.K. (1991). Plant genetic resources Conservation and Management. International Board for Plant Genetic

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- Resources, (IBPGR), Rome, (Italy)
- Shantharam, S. and Montgomery, J.F. (1999). Biotechnology, Biosafety and Biodiversity. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
 - Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
 - Taiz, L., Zeiger, E., (2014). Plant Physiology. Sinauer Associates Inc., U.S.A. 6th Edition.
 - Vasil, I.K. and Thorpe, T.A (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers, Netherlands.

Semester-IV

Undergraduate Diploma in Botany

Generic Elective: Inheritance in Plant Biology

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Inheritance in Plant Biology	4	4	0	0	Passed class	Nil

UNDERGRADUATE DIPLOMA IN BOTANY		
Programme: Undergraduate Diploma in Botany		Year: II Semester: IV
Subject: Botany		
Course: BOT GE 4	Inheritance in Plant Biology	

Course Outcomes:

After the completion of the course the students will be able to

1. Understand the concepts and principles of inheritance and sex determination.
2. Students will get familiarized with causal agents of genetic changes (mutations).
3. Learn how genetic information is used to detect diseases and also to establish unique identity of an individual.

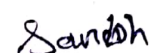
Credits:4	Generic Elective
Max.Marks:As per Univ. rules	Min.Passing Marks:As per Univ.rules

Unit	Topic	No. of Hours (60)
1	Chromosomal Inheritance: Principles of Mendelian inheritance, Incomplete dominance and co- dominance; Multiple allelism; lethal alleles; Linkage and crossing over. Extra-chromosomal Inheritance: Chloroplast Inheritance, Cytoplasmic inheritance.	15
2	Chromosome structure and alterations in chromosome: Structural alterations in chromosome: duplication, deficiency, inversion and translocation Numerical alterations in chromosome: Euploidy, Aneuploidy and Polyploidy.	20
3	Mutation: spontaneous and induced mutation; physical and chemical mutagens; Consequences of mutation.	15
4	Demonstration of different structures of chromosomes and changes in chromosome structure	10

Suggested Readings

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.





- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.
- Campbell, N.A., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V., Reece, J.B. (2020). Biology, 12th Edition. Harlow, England : Pearson

Semester-V

Bachelor of Science in Botany

Generic Elective: Medicinal Plants of Uttarakhand

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Medicinal Plants of Uttarakhand	4	4	0	0	Passed Class	Nil

BACHELOR OF SCIENCE IN BOTANY		
Programme: Bachelor of Science in Botany		Year: III Semester: V
Subject: Botany		
Course: BOT GE 5	Medicinal Plants of Uttarakhand	

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Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the diversity and distribution of medicinal plants in Uttarakhand
2. Study the techniques/methods for the sustainable utilization of the medicinal plants.
3. Understand the economic importance of medicinal plants of Uttarakhand.

Credits:4	Generic Elective
Max.Marks:As per Univ. rules	Min.Passing Marks:As per Univ.rules

Unit	Topic	No. of Hours (60)
1	General idea of Indian systems of medicine (Ayurveda, Siddha, Unani, Tibetan, Yoga and Naturopathy) and the traditional medicinal system of Uttarakhand. Brief history, prospects and uses of important medicinal plants of Uttarakhand Himalaya, scope and importance of medicinal plants, challenges in medicinal plant sector.	20
2	Diversity, distribution, assessment and indigenous uses of threatened medicinal plants of Uttarakhand. Collection and processing of medicinal plants; methods for documentation of traditional medicine knowledge.	15
3	Promotion of medicinal plant sector at national level: National Medicinal Plant Board and State Medicinal Plant Boards- objectives and functions. Other organizational initiatives for promotion of MAPs at National and International levels. Demand and supply of medicinal plants. Conservation, threats, IUCN Red list criteria and management of threatened medicinal plants of Uttarakhand.	15

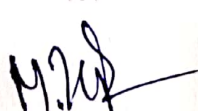
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4	Demonstration and identification of some important medicinal plants	10
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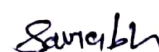
Suggested Readings

- Anonymous. (2014). Herbal Wealth of Uttarakhand Vol. I & II. Central Council for Research in Ayurvedic Sciences, New Delhi.
- Arber, A. (1999). Herbal plants and Drugs. Mangal Deep Publications.
- Arya, D., Joshi, G.C. and Tewari, L.M. 2018. Crude drugs plants of Uttarakhand. Indu Book Services Pvt. Ltd. (Publishers & Distributors) New Delhi.
- Bhatt, D., Joshi, G.C., Tewari, L.M. and Pandey, N.C. (2020). Traditional Medicinal Systems and Threatened Medicinal Plants of Kumaun, Western Himalaya, India. Indu Book Services Pvt. Ltd. (Publishers & Distributors) New Delhi.
- Chhetri, D.R. (2015). Medicinal Plants of the Himalaya: Production Technology and Utilization. Agrobios (India).
- Chopra, R.N., Nayar S.L. and Chopra, I.C. (1956). Glossary of Indian Medicinal Plants, C.S.I.R., New Delhi.
- Kala, C.P. (2010). Medicinal Plants of Uttarakhand: Diversity, Livelihood and Conservation, Biotech Books.
- Pandey, P.C., Tewari, L. and Pande, H.C. (2006). Folk Medicine and Aromatic Plants Of Uttaranchal, Bishen Singh Mahendra Pal Singh, Dehradun.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Herbs, Grasses and Ferns. Vol. II. Gyandodaya Prakashan, Nainital.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Tree, shrubs and Climbers. Vol. I. Gyandodaya Prakashan, Nainital.
- Tewari, L.M., Singh, N., Upreti, K. and Pangtey, Y.P.S. (2008). Medicinal Plants of Ranikhet Consul Book Depot, Nainital.









Semester-VI

Bachelor of Science in Botany

GENERIC ELECTIVE (GE): Global Climate Change

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Global Climate Change	4	4	0	0	Passed Class	Nil

BACHELOR OF SCIENCE IN BOTANY			
Programme: <i>Bachelor of Science in Botany</i>		Year: III	Semester: VI
Subject: Botany			
Course: BOT GE 6	Global Climate Change		
Course Outcomes:			
After the completion of the course the students will be able to:			
1. Understand the global climate changes and global warming.			
2. Learn about the measures being taken for the mitigation of climate changes.			

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No.of Hours (60)
1	General concept of Global climate change, Impact of global warming and climate change, Greenhouse effect, Greenhouse gases, Carbon foot print, Carbon trading, Carbon sequestration.	15
2	Introduction to climate change adaptation, Mitigation strategies for global warming, International initiative for mitigating global climate changes; Inter governmental panel on climate change (IPCC); United Nation Framework convention on Climate change (UNFCCC).	15
3	Climate change policy and international solutions, Conference of Parties (COP), Kyoto protocol; Montreal protocol; Paris Pact; India's initiatives for mitigating climate change.	15
4	To assess the carbon footprint and carbon sequestration potential of different forest types.	15

Suggested Readings

- Singh, S., Singh, P., Rangabhashiyam, S. and Srivastava, K.K. (2021). Global Climate Change, Elsevier.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Mathez, E. A. and Smerdon, J. (2009). Climate Change- The Science of Global Warming and Our Energy Future, Columbia University Press.

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Semester VII

GENERIC ELECTIVE (GE)-MOLECULAR BIOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Molecular Biology	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

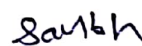
Programme: <i>Master of Science in Botany</i>		Year: IV	Semester: VII
Subject: Botany			
Course: BOT GE7	Course Title: Molecular Biology		
Course outcomes: After the completion of the course the students will be able to 1. Learn the structure and function of nucleic acids at molecular level. 2. Understand the concept of central dogma and genetic code. 3. Learn molecular details of DNA replication and its types. 4. Understand transcription and translation including post-transcriptional and post-translational modifications of transcripts and polypeptides/proteins			

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Nucleic acids as carriers of genetic information: Experiments that established nucleic acids (DNA & RNA) as the carrier of genetic information: Griffith's, Hershey & Chase, Avery, McLeod & McCarty and Fraenkel-Conrat's experiment. Structure and organization of the genetic material: DNA double helix structure (Watson and Crick model); salient features of DNA double helix. Types of DNA: A, B & Z conformations, denaturation and renaturation (only melting profile- T_m), types of RNA (mRNA and rRNA, tRNA).	12
2	Central Dogma and Genetic Code: The Central Dogma, Genetic code and its salient features, Experiments for deciphering Genetic code (Experiments by Nirenberg & Matthaei and Har Gobind Khorana). Replication of DNA : Mechanism - initiation, elongation and termination; Enzymes and other proteins involved in DNA replication; General principles - bidirectional, semiconservative and semi discontinuous replication (Replisome), RNA priming (Primase & Primosome); Various modes of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA. Replication of the 5' end of linear chromosome (end replication problem & Telomerase).	20
3	Mechanism of Transcription : Transcription process in prokaryotes (Initiation, Elongation and Termination); structure and function of RNA polymerase enzyme; concept of promoters and transcription factors; major differences between prokaryotic and eukaryotic transcription; concept of post	20



	transcriptional modifications (eukaryotic mRNA processing: 5' capping; 3' tailing). Mechanism of Translation : Translation in prokaryotes: Initiation, Elongation and Termination; concept of charging of tRNA and role of aminoacyl synthetases; ribosome structure and assembly (in prokaryotes and eukaryotes); major differences between prokaryotic and eukaryotic translation; post-translational modifications (concept of phosphorylation, glycosylation - briefly).	
4	Demonstration of double helical structure of DNA, replication, transcription and translation with 3-D structure through powerpoint presentation	8

Suggested Readings

- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York, USA.
- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). Molecular Biology of the Cell. Garland Publishing Inc., New York. 6th edition.
- Watson, J.D. (2013). Molecular Biology of the Genes, Benjamin. 7th Edition.
- Wolfe, S.L. (1993). Molecular and Cellular Biology. Wadsworth Publishing Co. California.
- Stent, G.S. (1986). Molecular genetics. Bishen Singh Mahendra Pal Singh, Dehradun.
- Barry, J.M. and Barry, B.M. (1973). Molecular Biology, Prentice Hall of India. New Delhi.

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Semester VII

GENERIC ELECTIVE (GE)- FUNDAMENTALS OF BIOCHEMISTRY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Fundamentals of Biochemistry	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: <i>Bachelor in Botany With Honours</i>		Year: IV	Semester: VII
Subject: Botany			
Course: BOT GE 8	Course Title: Fundamentals of Biochemistry		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the structure, classification and functions of biochemical compounds. 2. Understand the structure, functions and biochemical pathway of secondary metabolites. 3. Understand the catalytic mechanism of enzymes, their inhibitors and regulation.			

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Carbohydrates: structure and function of monosaccharides, oligosaccharides, polysaccharides, Glycolysis, Feeder pathway Lipids: Fat metabolism (simple lipids, compound lipids, derived lipids), fat metabolism, β -oxidation of fats.	15
2	Proteins: Amino acids, structure of primary, secondary, tertiary, quaternary proteins, Ramachandran plot, protein sequencing. Secondary metabolites: Alkaloids, flavanoid, terpenoid and their biosynthetic pathway.	15
3	Enzymology: General aspects, allosteric mechanism, regulatory and active sites, isozymes, kinetics of enzymatic analysis, Michaelis-Menten equation and its significance, enzyme inhibition (competitive, uncompetitive and non-competitive).	20
4	To test the presence of different substrates in given samples. To estimate R.Q. of different substrates.	10

Suggested readings

- Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biotechnology. Macmillan, 8th Edition.
- Srivastava, H.S. (2003). Elements of Biochemistry. Rastogi Publications, Meerut.
- Cooper, T.G. (1977). Tools in Biochemistry. Wiley New York.
- Bosch, C. (1972). Mechanism of Protein Synthesis and its Regulation. Elsevier Pub. Comp. N. York.
- Ribonsen, T. (1968). The biochemistry of Alkaloids Springer Verlag, Berlin
- Meister, A. (1965). Biochemistry of the Amino acids. 2 vols. Academic Press, New York

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Semester VIII

GENERIC ELECTIVE (GE)-METHODS IN PLANT BIOLOGY AND THEIR APPLICATIONS

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Methods in Plant Biology and their Applications	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: <i>Bachelor in Botany with Honours</i>	Year:IV	Semester: VIII
Subject:Botany		
Course:BOTGE9	Course Title:Methods in Plant Biology and their Applications	
Course outcomes: After the completion of the course the students will be able to: 1. Gain the knowledge of various techniques and instruments used for the study of plant biology. 2. Understand the principles and use of light, confocal and electron microscopy, Principles of centrifugation, spectrophotometry, chromatography, x-ray diffraction technique and chromatography techniques.		

Credits: 4	Generic Elective
Max. Marks:	Min. Passing Marks: As per Univ. rules





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Unit	Topic	No.ofHours (60)
1	Plantsand Intelligence Introduction to plant Intelligence and memory-Historical perspective, Sensory Biology, Cell to cell communication, Self-recognition, Recognition of neighbors and relatives.	15
2	Principles of Microscopy Dissection and light and compound microscope, electron microscope (SEM and TEM), importance of sample preparation for microscopy, staining techniques, micrometry. Histo-chemical and Immunotechniques Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.	20
3	Biophysical Method Molecular analysis using UV/visible and fluorescence, spectrophotometer, circular dichroism, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction and NMR, molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.	15
4	Demonstration of different instruments used in plant biology	10

Suggested Readings

- Trewavas A. (2017). The foundations of plant intelligence. Interface Focus 7: 20160098.
<http://dx.doi.org/10.1098/rsfs.2016.0098>
- Wilson, K., Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
- Koller, D. (2011). The Restless Plant. Edited by Elizabeth Van Volkenburgh, Harvard University Press, Cambridge, Massachusetts, and London, England.





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Semester VIII

GENERIC ELECTIVE (GE) – TRADITIONAL KNOWLEDGE SYSTEM

No. of Hours - 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Traditional Knowledge System	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN BOTANY WITH HONOURS

Programme: <i>Bachelor in Botany with Honours</i>	Year:IV	Semester: VIII
Subject:Botany		
Course:BOTGE10	Course Title:Traditional Knowledge System	
Course outcomes: After the completion of the course the students will be able to: 1. Understand the concept, scope and importance of traditional knowledge. 2. Study the traditional knowledge systems of major tribal communities of Uttarakhand. 3. Explain the need for and importance of protecting traditional knowledge. 4. Interpret the concepts of Intellectual property in order to protect the traditional knowledge.		

Credits: 4	Generic Elective
Max. Marks:	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (60)
1	Traditional knowledge: Introduction, nature and characteristics, scope and importance, Kinds of traditional knowledge (Unani/Siddha/Ayurveda), Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge of Uttarakhand. Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.	20
2	Traditional knowledge and intellectual property: Systems for protection of traditional knowledge, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Geographical Indications (GI).	15
3	Aspects of Biodiversity and Indian Traditions: Traditional knowledge of Uttarakhand: With special reference to food, agriculture and medicine. Tribal communities (Raji, Bhotia, Tharu and Boxa) of Uttarakhand: their culture and traditional knowledge on the utilization of plants. Traditional Knowledge and its implication in modern society, Traditional Knowledge Digital Library (TKDL).	15
4	Methods of documenting uses of plants in traditional practices	10

Suggested readings

- Jha, A. (2009). Traditional Knowledge System in India,
- Kappor, K. (). Knowledge Traditions and Practices of India.
- Pande, P. C. Madhya Himalaya Sanskrit in Gyan, Vigyan evam Paravigyan.
- Ram Reddy, S. Surekha, M. and Krishna Reddy, V (2016). Biodiversity Traditional Knowledge Intellectual Property Rights. Scientific Publishers.
- Unnikrishna, P and Suneetha, M. (2012). Biodiversity, traditional knowledge and community health: strengthening linkages. Institute for Advanced Studies, United Nations University, Tokyo.
- TKDL (www.tkd1.res.in) online resources.

Semester IX

GENERIC ELECTIVE (GE)-FOREST ECOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Forest Ecology	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY

MASTEROFSCIENCEINBOTANY			
Programme:MasterofScienceinBotany		Year: V	Semester:IX
Subject:Botany			
Course:BOT GE 11	CourseTitle:ForestEcology		
CourseOutcomes: Afterthecompletionofthecoursethestudentswillbeable to: 1. Understandthestructureandfunctionofforestecosystem. 2. Understandmethodsforstudyingvegetation,communitypatternandprocesses, ecosystem function, biodiversity, carbon stock and carbon sequestration. 3. Understandthestudentstounderstandthelinkagebetweenhumansandforests.			

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Sana H

Unit	Topic	No. of Hours (60)
1	General Aspects of Forests: Forest ecology and forest ecosystems, Importance of forests in environmental conservation Primary Productivity and Detritus Pool; Formulation of Primary Productivity: Photosynthetic pathways and their significance; Allocation of Net primary production and biomass accumulation; Measurement of biomass and primary productivity in forest ecosystems of the world; Plant biomass and turnover; Human Use of productivity.	15
2	Litter fall in Forest Ecosystems; determining litter fall, factors affecting it; Forest litter: type of litter; Coarse Woody debris; forest floor litter mass. Detritus Pathway of Energy Flow and Decomposition Processes: Decomposer organisms and their trophic interactions; decomposition processes; Measurements of Litter decomposition; decomposition rate. Nutrient cycling in forest ecosystems: nutrient cycle models in forest ecosystem. Nutrient supply and uptake, Role of mycorrhizae in nutrient cycling; Nutrient concentration and storage in vegetation.	15
3	Succession: Overview on forest succession with focus on Himalayan forest ecosystem; Attributes of species of different successional stages Major forest types of forest India: Forest classification of India; Forest of Himalaya with particular reference to Sal, Pine and Oak forests.	20





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	Global climate changes and forests. Man and forest: Commercial exploitation of forest, shifting agriculture; settled agriculture; structure and functioning of Central Himalayan Agroecosystem. Regeneration status of major forest trees with respect to acute vs. chronic human disturbance; Shifting cultivation practices.	
4	Assessment of forest biomass, carbon sequestration, primary productivity and regeneration pattern of different forests.	10

Suggested readings

- Bir, S.S. and Chatha, G.S. (1988). Forest Vegetation Characteristics of Indian Hills. Today and Tomorrow's Printers & Publ., New Delhi.
- Misra, R. (1968). Ecology Workbook. Oxford & IBH Publishing Co. New Delhi.
- Puri, G.S., Meher-Homji V.M., Gupta R. K. and Puri R. K. (1960). Forest Ecology. Oxford and IBH Pub. Co. Pvt. New Delhi.
- Singh, J.S. and Singh, S.P. (2014). Forest of Himalaya: structure, Function and Impact of Man. Gyanodaya Prakashan, Nainital, India.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Waring, R.H. and Schlesinger, W.H. (1985). Forest Ecosystems: Concepts and Management. Academic Press, New York.

Semester IX

GENERIC ELECTIVE (GE) – HERBARIUM TECHNIQUES

No. of Hours - 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Herbarium Techniques	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY

MASTER OF SCIENCE IN BOTANY			
Programme: <i>Master of Science in Botany</i>		Year: V	Semester: IX
Subject: Botany			
Course: BOT GE 12	Course Title: Introduction of Herbarium And Its Significance		
Course outcomes: After the completion of the course the students will be able to			
1. Understand the processing and importance of Herbarium. 2. Learn about the preparation of Flora. 3. Learn the basic techniques of classification. 4. Understand the collection and identification of plants.			

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Sana H

Unit	Topic	No. of Hours (60)
1	Herbarium: History, Introduction, Methods of Collection of Specimens, Tools and Equipment, Botanical Gardens. Herbarium Preparation (a. Poisoning, b. Pressing, c. Drying, d. Mounting, e. Documentation, f. Arrangement, g. Maintenance h. Cataloging)	20
2	Types of herbaria (International, National, Regional and University, Medicinal plant, Economically important plant, Agricultural herbaria), Important herbaria of the World, Major Herbaria in India, Acronym.	15
3	Role of Herbarium in Teaching and Research, Function of Herbarium and Conservation, Digitization, Virtual Herbarium.	15
4	Visit to herbarium; demonstration and preparation of herbarium from local flora	10

Suggested readings

- Saxena, N.B. and Saxena, S. (2012). Plant Taxonomy. Pragati Prakashan.
- Jain, S.K. and Rao, R.R. (1976). A Handbook of Field and Herbarium Methods.
- Sambamurthy A. V.S.S. (2010). Taxonomy of Angiosperms. I.K. International Pvt. Ltd.
- Singh, G. (2010). Plant Systematics. CBS PUB & DIST PVT Limited INDIA.
- Sharma, O.P. (2009). Plant Taxonomy. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Gaur R.D. (1999). Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.

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Semester X

GENERIC ELECTIVE (GE): LICHENOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Lichenology	4	4	0	0	Botany in Honours Degree	Nil

MASTER OF SCIENCE IN BOTANY

Programme: Master of Science in Botany

Year: V

Semester: X

Subject: Botany

Course: BOT GE 13

Course Title: Lichenology

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the general characters, structure, types, reproduction and various habitats of lichens.
2. Develop conceptual skill about identifying fungi and lichens.
3. Understand the physiology and biochemistry of lichens.
4. Study the ecological and economic importance of lichens.
5. Gain knowledge about the major lichen families and their representative genera.

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (60)
1	Introduction, General characteristics of lichens, history of Lichenology, collection and preservation of lichens, habitat and growth form of lichens. Classification of lichens. Morphology and anatomy of lichens, Reproduction in lichens.	20
2	Physiology and chemistry of lichens, ecological and economic importance of lichens, Overview of some common lichens of Uttarakhand Himalaya.	15
3	Salient features of Parmeliaceae, Lecanoraceae, Teloschistaceae, Ramalinaceae, Physciaceae, Collemataceae, Candelariaceae, Peltigeraceae and Usneaceae.	15
4	Methods to identify different lichens. Demonstration of different lichen specimens	10

Suggested readings

- Arya, V., Kumar, B. and Arya, P. (2019). Lichen Wealth of Uttarakhand Himalaya. Lap Lambert Academic Publishing.
- Awasthi, D.D. (2000). Handbook of lichens, Bishen Singh Mahendrapal Singh: Dehradun India.
- Awasthi, D.D. (2007). A compendium of the macrolichens of India, Nepal and Sri Lanka. Dehradun Bishen Singh Mahendrapal Singh: Dehradun India.
- Sati, S.C. and Pant, P. (2023). A test Book on Lichens: The Endolichenic Fungi. Elite Publishing House, New Delhi.
- Webster, J. (1985). Introduction to Fungi. Cambridge University Press. New York.

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Semester X

GENERIC ELECTIVE (GE): PALAEOBOTANY

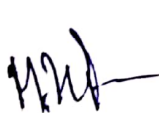
No. of Hours-60

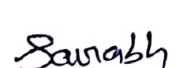
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Paleobotany	4	4	0	0	Honours Degree in Botany	Nil

MASTER OF SCIENCE IN BOTANY		
Programme: <i>Master of Science in Botany</i>		Year: V Semester: X
Subject: Botany		
Course: BOT GE 14	Course Title: Paleobotany	
Course Outcomes: After the completion of the course the students will be able to: 1. To understand the importance of paleobotany in plant science. 2. To understand the process of fossilization and factors affecting the process of fossilization.		

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules



Unit	Topic	No. of Hours (60)
1	Definition and importance of Paleobotany, Principles of Paleobotany Geological time scale Fossil; Definition, types and mode of preservation Fossilization: Theories and factors affecting the process of fossilization Nomenclature and reconstruction of fossil plants Methods of study of fossils and carbon dating technique	20
2	Origin and evolution of life: Overview of the earliest environment on Earth, Basic concepts and theories about origin of life. Applied Paleobotany: Fundamentals of paleo-floristics, paleogeography, paleoecology and paleoclimatology	15
3	Colonization of land: Emergence of seed plants, appearance of angiosperms, basic concept of continental drift, Paleobotany in India, Gondwana flora	15
4	Demonstration of different types of fossils through preserved specimens	10

Suggested readings

- C.A. Arnold. (1947). An introduction to Paleobotany
- J. Walton. (1940). An introduction to the study of fossil plants

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Skill Enhancement Course: Mushroom Cultivation I

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Mushroom Cultivation I	2	1	0	1	Passed class XII	Nil

Skill Enhancement Courses in Botany

Skill Enhancement Courses in Botany			
Programme: Skill Enhancement Courses in Botany		Year: I	Semester: I
Subject: Botany			
Course: BOT SEC MC1	Mushroom Cultivation I		
Course Outcomes: The successful students will be able to: 1. Understand the economic importance of mushroom cultivation. 2. To learn the basic tools and techniques used in mushroom cultivation. 3. To learn the skills for developing commercial enterprise of mushroom cultivation.			

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No.of Hours (15)
1	Introductiontomushroomsandtheireconomicimportance Scope of mushroom cultivation in India Nutritional andmedicinalvalueof mushrooms Importantedibleandmedicinal mushrooms	15

Practical/Lab Course BOT SEC MCIP

Unit	Topic	No.of Hours (30)
1	Fieldvisittothenearbyareaforidentificationofnaturallygrowingmushroom species Collection techniques and preservation of mushrooms Introductiontolaboratoryequipmentformushroomcultivation Visittomushroomcultivationlaboratory/farm	30

Skill Enhancement Course: Mushroom Cultivation II

No.of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Mushroom Cultivation II	2	1	0	1		Nil

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Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany	Year: I	Semester: II
Subject: Botany		
Course: BOT SEC MC2	Mushroom Cultivation II	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Spawn and the methods of spawn production Selection and preparation of substrates (compost) for mushroom cultivation Sterilization and pasteurization techniques Storage and transportation of spawn and substrates	15

Practical/Lab Course BOT SEC MC2P

Unit	Topic	No. of Hours (30)
1	Preparation and multiplication of spawn Procedure for testing the spawn quality Methods and equipment used in sterilization and pasteurization of compost Methods of substrate preparation for different mushroom species	30

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Skill Enhancement Course: Mushroom Cultivation III

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Mushroom Cultivation III	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: II Semester: III
Subject: Botany		
Course: BOT SEC MC3	Mushroom Cultivation III	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Cultivation of Button mushroom Cultivation of Oyster mushroom Cultivation of Shiitake mushroom Cultivation of medicinal mushrooms (<i>Cordyceps</i> and <i>Ganoderma</i>)	15





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Practical/Lab Course BOT SEC MC3P

Unit	Topic	No. of Hours (30)
1	Inoculation and Incubation techniques of spawn. Monitoring of growth in cultivation rooms Methods of harvesting and quality assessment techniques Yield estimation in different cultivation methods	30

Skill Enhancement Course: Mushroom Cultivation IV

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Mushroom Cultivation IV	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: II Semester: IV
Subject: Botany		
Course: BOT SEC MC4	Mushroom Cultivation III	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules





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Unit	Topic	No. of Hours (15)
1	Common diseases impacting the cultivation of mushrooms Methods for controlling diseases during mushroom cultivation Pest management during mushroom cultivation Hygiene and sanitation of cultivation rooms	15

Practical/Lab Course BOTSECMC4P

Unit	Topic	No. of Hours (30)
1	Identification of common diseases in mushrooms Isolation of pathogens from mushrooms Study of bio-control agents used to protect mushrooms Training on integrated pest management	30

Skill Enhancement Course: Mushroom Cultivation V

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Mushroom Cultivation V	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: III Semester: V
Subject: Botany		
Course: BOT SEC MC5	Mushroom Cultivation V	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Methods for storage of mushrooms Value added products from mushrooms Nutraceutical from the mushrooms Safety standards in mushroom products	15




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Practical/Lab Course BOT SEC MC5P

Unit	Topic	No. of Hours (30)
1	Techniques of drying and preservation of mushrooms Development of value added products from mushrooms Quality testing of mushroom products Visit to mushroom processing unit	30

Skill Enhancement Course: Mushroom Cultivation VI

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Mushroom Cultivation 6	2	1	0	1		Nil

Skill Enhancement Courses in Botany

Programme: Skill Enhancement Courses in Botany			Year: III	Semester: VI
Subject: Botany				
Course: BOT SEC MC6	Mushroom Cultivation VI			

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No.of Hours (15)
1	Government schemes and subsidies in mushroomcultivation Cost-benefitanalysisforsettingamushroomcultivationunit Marketing strategies for mushrooms Supplychainmanagementfor mushrooms	15

Practical/Lab Course BOTSECMC6P

Unit	Topic	No.of Hours (30)
1	Preparationofabusinessplanformushroomfarm Market survey on the demand of mushrooms Liaisingwiththemushroom'ssellers/users(hostels,restaurants,vegetablesellers) Interactions with successful mushroom entrepreneurs	30

Suggested Readings

- Bahl,N.(2000).HandbookofMushrooms.Oxford&IbhPublishingCo.PvtLtd.
- Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
- Swaminathan, M. (1990). Food and Nutrition. Bappco, The Bangalore Printing andPublishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
- Tewari,P.andKapoor,S.C.(1988).Mushroomcultivation,MittalPublications,Delhi.

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Skill Enhancement Course: Hydroponics I

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Hydroponics I	2	1	0	1		Nil

Skill Enhancement Courses in Botany

Programme: Skill Enhancement Courses in Botany

Year: I

Semester: I

Subject: Botany

Course: BOT SEC H1

Hydroponics I

Course Outcomes:

The successful students will be able to:

1. Develop a thorough understanding of the concepts of Hydroponics
2. Students will be trained in establishing hydroponic facility.
3. Students will understand various government policies in marketing of hydroponic produce.

Credits: 2

Skill Enhancement Course

Max. Marks: As per Univ. rules

Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Introduction, Basic principles of hydroponics Importance and scope of hydroponic system Types of hydroponic systems: Nutrient Film Technique (NFT), Deep Water Culture (DWC), ebb and flow, drip irrigation and wick system Advantages and disadvantages of hydroponics over traditional farming	15

Practical/Lab Course BOTSECH1P

Unit	Topic	No. of Hours (30)
1	Setting up a basic hydroponics system Identifying different hydroponic setups and their components Introduction to different growing media for hydroponics system.	30

Skill Enhancement Course: Hydroponics II

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Hydroponics II	2	1	0	1	Skill Enhancement Courses in Botany	Nil

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Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany	Year: I	Semester: II
Subject: Botany		
Course: BOT SEC H 2	Hydroponics II	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Basic plant physiology relevant to hydroponics Essential nutrients and their role in plant growth Nutrient solutions: Preparation and management pH and EC balancing in hydroponic systems Water quality management and filtration techniques in hydroponic system	15

Practical/Lab Course BOT SEC H 2P

Unit	Topic	No. of Hours (30)
1	Preparing and adjusting nutrient solutions for hydroponic farming	30

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	Testing and adjusting pH and EC levels	
	Identifying nutrient deficiencies and toxicities	
	To know about setup preparation of different hydroponics system	

	Skill Enhancement Course: Hydroponics III
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No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Hydroponics III	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: II Semester: III
Subject: Botany		
Course: BOT SEC H 3	Hydroponics III	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
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1	Designing small-scale and commercial hydroponic farms Management of environmental factors: Light, temperature, humidity, and CO ₂ management Water and nutrient recirculation techniques Common pests and diseases in hydroponics and their management	15
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Practical/Lab Course BOTSECH3P

Unit	Topic	No. of Hours (30)
1	Designing and assembling a hydroponics system Installing and maintaining environmental control systems System maintenance and troubleshooting Pest and disease identification and their management	30

Skill Enhancement Course: Hydroponics IV

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Hydroponics IV	2	1	0	1		Nil

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Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany	Year: II	Semester: IV
Subject: Botany		
Course: BOT SEC II 4	Hydroponics IV	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Selection of crops suitable for hydroponic cultivation Propagation and transplanting techniques in hydroponics system. Growth cycles and yield optimization Vertical farming techniques and urban hydroponics Organic hydroponics and sustainable practices	15

Practical/Lab Course BOT SECH 4P

Unit	Topic	No. of Hours (30)
1	Growing leafy green vegetables, herbs, and fruiting plants in hydroponic systems Implementing vertical farming techniques Experiments related to organic hydroponics solutions	30

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	Intercroppingandmixedcroppinginhydroponics	
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Skill Enhancement Course: Hydroponics V

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Hydroponics V	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: III Semester: V
Subject: Botany		
Course: BOT SEC II 5	Hydroponics V	

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Credits:2	Skill Enhancement Course
Max.Marks:As per Univ. rules	Min.Passing Marks:As per Univ.rules

Unit	Topic	No.of Hours (15)
1	Market value of hydroponic farming Market analysis and business planning Cost-benefit analysis for setting a Hydroponics system Branding, marketing, and selling hydroponic produce Certification and regulatory guidelines for hydroponic produce	15

Practical/Lab Course BOTSECH5P

Unit	Topic	No.of Hours (30)
1	Creating a business plan for a hydroponic farm Market research and analysis- Packaging, labeling, and pricing strategies Visit to a commercial hydroponic farm	30

Skill Enhancement Course: Hydroponics VI

No.of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		

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Hydroponics6	2	1	0	1		Nil
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Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany	Year: III	Semester: VI
Subject: Botany		
Course: BOT SEC H 6	Hydroponics VI	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Government schemes and subsidies in Hydroponic farming Recent trends and innovations in hydroponics Research methodologies in hydroponic agriculture Climate-resilient hydroponic farming techniques Policy and future prospects of hydroponics	15

Practical/Lab Course BOT SEC H 6P

Unit	Topic	No. of Hours (30)
1	Preparation of a business plan for Hydroponic farming system Interactions with successful Hydroponic farmers Developing a prototype hydroponics system	30

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Suggested Readings

- Jr. Jones, J.B. (2014). Complete guide for growing plants hydroponically, CRC Press, London.
- Hasan, M., Sabir, N., Singh, A.K., Singh, M.C., Patel, N., Khanna, M., Rai, T., Pragnya, P. (2018). Hydroponics Technology for Horticultural Crops, Tech. Bull. TB-ICN 188/2018. Publ. by I.A.R.I., New Delhi-110012 INDIA.

Skill Enhancement Course: Nursery Development and Floriculture-I
No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Nursery Development and Floriculture-I	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany	Year: I	Semester: I

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Subject: Botany	
Course: BOT SEC NF1	Nursery Development and Floriculture-I
Course Outcomes: The successful students will be able to: 1. Develop conceptual of nursery and gardening. 2. Gain knowledge about developing commercial enterprise of nursery. 3. Develop conceptual skill about floriculture. 4. Gain knowledge about developing commercial enterprise of commercial floriculture.	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Introduction to Nursery & Floriculture Types of Nurseries Basic plant Classification & Nomenclature Importance of Soil & Water in Nursery Management Common Nursery Tools & Equipment	15

Practical/Lab Course BOT SEC NF1P

Unit	Topic	No. of Hours (30)
1	Site Selection and Layout Planning for nursery development	30

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	Soil Preparation and Bed Making Seed Sowing and Germination Techniques Identification & Use of Tools used in Nursery Basic Watering & Irrigation Methods	
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	Skill Enhancement Course: Nursery Development and Floriculture-II
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No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Nursery Development and Floriculture-II	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: I Semester: II
Subject: Botany		
Course: BOT SEC NF 2	Nursery Development and Floriculture-II	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours
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		(15)
1	Methods of Plant PropagationSeedPropagation&ItsI mportance VegetativePropagation(Cutting,Grafting,Layering) Micropropagation (Tissue Culture Basics) RoleofPlantGrowthRegulatorsFactors.AffectingPlantGrowth Hardeningofplantsinglasshouse,mistchamberetc.	15

Practical/Lab Course BOTNF 2P

Unit	Topic	No.of Hours (30)
1	Hands-on Seed Propagation in nursery Grafting & Cutting Techniques Layering&RootingMediaPreparation Use of plant Growth Regulators Hardening & Acclimatization NurseryHygiene&Sanitation	30

Skill Enhancement Course:NurseryDevelopmentandFloriculture-III

No.ofHours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

CourseTitle	Credits	CreditdistributionoftheCourse			Eligibility criteria	Pre- requisiteof the Course (ifany)
		Lecture	Tutorial	Practical/Practice		
Nursery Developmentand Floriculture-III	2	1	0	1		Nil

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Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany	Year: II	Semester: III
Subject: Botany		
Course: BOT SEC NF 3	Nursery Development and Floriculture-III	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Nursery Layout Planning & Design Watering, Fertilization & Pest Control in nursery Selection of Planting Material Nursery Commercialization & Market Trends Certification & Quality Control Legal Aspects & Policies in nursery	15

Practical/Lab Course BOT SEC NF 3P

Unit	Topic	No. of Hours (30)
1	Setting Up a Small Nursery Drip Irrigation & Fertilization Pest & Disease Control of plants Maintenance & Pruning, Labeling & Packaging of Plants Visit to local commercial Nursery	30

Skill Enhancement Course: Nursery Development and Floriculture-IV

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Nursery Development and Floriculture-IV	2	1	0	1		Nil

Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: II Semester: IV
Subject: Botany		
Course: BOT SEC H 4	Nursery Development and Floriculture-IV	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Introduction to Floriculture Importance and scope of floriculture Classification of Ornamental Plants	15





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Cultivation Techniques for some Important Flowers Landscape Designing Principles used in floriculture Greenhouse & Polyhouse Technology	
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Practical/Lab Course BOTSECNF4P

Unit	Topic	No. of Hours (30)
1	Growing Flowers in Open & Protected Conditions Designing Flower Beds & Lawns Flower Arrangement & Bouquet Making Greenhouse/Playhouse Setup for flower production Pest management Visit to a Floriculture Farm	30

Skill Enhancement Course: Nursery Development and Floriculture-V

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Nursery Development and	2	1	0	1		Nil

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Floriculture-V						
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Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany	Year: III	Semester: V
Subject: Botany		
Course: BOT SEC NF 5	Nursery Development and Floriculture-V	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Harvesting & Post-Harvest Handling of Flowers Storage & Transportation Techniques Dry Flower Technology & Preservation Essential Oils & Their Extraction from flowers Value-Added Products from Flowers	15

Practical/Lab Course BOT SEC NF 5P

Unit	Topic	No. of Hours (30)
1	Post-Harvest Handling Techniques Techniques of flower Drying & Preservation Development of value added products from flowers Packaging & Marketing Training in a Floriculture Industry	30

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Skill Enhancement Course: Nursery Development and Floriculture-VI

No. of Hours-45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Nursery Development and Floriculture-6	2	1	0	1		Nil

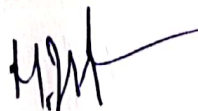
Skill Enhancement Courses in Botany		
Programme: Skill Enhancement Courses in Botany		Year: III Semester: VI
Subject: Botany		
Course: BOT SEC NF 6	Nursery Development and Floriculture-VI	

Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (15)
1	Marketing strategies for nursery development and flower production Government schemes and subsidies in nursery development and floriculture Cost-benefit analysis for setting a nursery	15

Practical/Lab Course BOTNF 6P

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Unit	Topic	No. of Hours (30)
1	Preparation of Small Nursery Business Plan Market survey on the demand of flowers Liaising with the flower sellers/users Training in a Nursery/Floriculture Startup	30

Suggested Readings

- Agrawal, P.K. (1993). Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
- Bose T.K. and Mukherjee, D. (1972). Gardening in India, Oxford and IBH Publishing Co., New Delhi.
- Jules J. (1979). Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.
- Kumar, N. (1997). Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
- Sandhu, M.K. (1989). Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
- Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.