

National Education Policy-2020

**Common Minimum Syllabus for
Uttarakhand State Universities and Colleges**

**Four Year Undergraduate
Programme- FYUP/Honours
Programme/Master in Science**

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

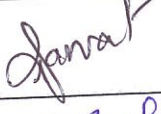
DEPARTMENT OF BOTANY

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Board of Studies (BOS) in Botany

Sri Dev Suman Uttarakhand University, Badshahithaul, Tehri Garhwal,
Uttarakhand

Committee Members

Sr. No.	Name	Designation	Institute	Signature
Departmental Member				
1.	Dr. Gulshan Kumar Dhingra	Professor & Head	Dept. of Botany, Pt. L.M.S. Campus, Rishikesh, SDSUU	
2.	Dr. Vidya Dhar Pandey	Professor	Dept. of Botany, Pt. L.M.S. Campus, Rishikesh, SDSUU	
3.	Dr. N. K. Sharma	Professor	Dept. of Botany, Pt. L.M.S. Campus, Rishikesh, SDSUU	
4.	Dr. Shalini Rawat	Associate Professor	Dept. of Botany, Pt. L.M.S. Campus, Rishikesh, SDSUU	
5.	Dr. S. K. Kuriyal	Assistant Professor	Dept. of Botany, Pt. L.M.S. Campus, Rishikesh, SDSUU	
6.	Dr. Preeti Khanduri	Assistant Professor	Dept. of Botany, Pt. L.M.S. Campus, Rishikesh, SDSUU	
External Expert				
7.	Dr. Mukesh Kumar	Professor & Head		

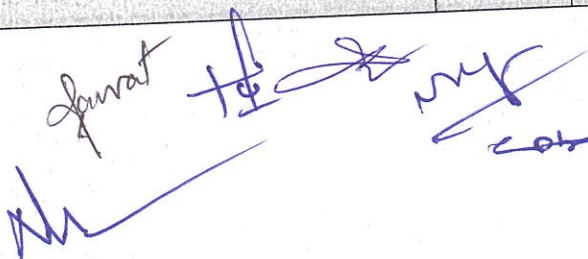


List of Papers (DSC, DSE, GE) with Semester Wise Titles for 'Botany'
(DSC-Discipline Specific Course; DSE-Discipline Specific Elective; GE-Generic Elective)

Year	Semester	Course	Paper Title	Theory/ Practical	Credits
Undergraduate Certificate in Botany					
FIRST YEAR	I	BOT DSC 1	Plant Diversity I (Microbes, Fungi and Algae)	Theory	3
		BOTDSC 1P	Practical/Lab Course BOT DSC 1P	Practical	1
		BOT GE 1	Plant Cell Biology	Theory	4
	II	BOT DSC 2	Plant Diversity II (Bryophyta, Pteridophyta and Gymnosperm)	Theory	3
		BOT DSC 2P	Practical/Lab Course BOT DSC 2P	Practical	1
		BOT GE 2	Plant Science – I	Theory	4
Undergraduate Diploma in Botany					
SECOND YEAR	III	BOT DSC3	Plant Systematics and Developmental Biology (Taxonomy, Embryology and Anatomy)	Theory	3
		BOT DSC3P	Practical/Lab Course BOT DSC 3P	Practical	1
		BOT DSE 1	Plant Tissue Culture	Theory	4
		BOT GE 3	Plant Science – II	Theory	4
	IV	BOT DSC4	Cytology, Genetics and Biotechnology	Theory	3
		BOT DSC4P	Practical/Lab Course BOT DSC 4P	Practical	1
		BOT DSE 2	Ethnobotany	Theory	4
		BOT GE 4	Inheritance in Plant Biology	Theory	4

Bachelor in Botany					
THIRD YEAR	V	BOT DSC5	Plant Physiology and Biochemistry	Theory	3
		BOT DSC5P	Practical/Lab Course BOT DSC 5P	Practical	1
		BOT DSE 3	Conservation and Management of Natural Resources	Theory	4
		BOT GE 5	Medicinal Plants of Uttarakhand	Theory	4
		BOT IAPC	Internship/Apprenticeship / Project/ Community Outreach	Theory/ Practical	2
	VI	BOT DSC6	Plant Ecology and Biostatistics	Theory	3
		BOT DSC6P	Practical/Lab Course BOT DSC 6P	Practical	1
		BOT DSE 4	Fundamentals of Molecular Biology	Theory	4
		BOT GE 6	Global Climate Change	Theory	4
		BOT IAPC	Internship/Apprenticeship / Project/ Community Outreach	Theory/ Practical	2

Bachelor in Botany with Honours					
FOURTH YEAR	VII	BOT DSC7	Cryptogams	Theory	3
		BOT DSC7P	Practical/Lab Course BOT DSC 7P	Practical	1
		BOT DSE 5	Plant Biotechnology	Theory	4
		BOT DSE 6	Microbiology	Theory	4
		BOT DSE 7	Plant Development and Reproductive Biology	Theory	4
		BOT GE 7	Molecular Biology	Theory	4
		BOT GE 8	Fundamentals of Biochemistry	Theory	4



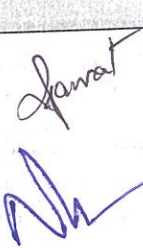
	VIII		Dissertation/Academic Project/ Entrepreneurship	Theory/ Practical	6
		BOT DSC8	Phanerogams	Theory	3
		BOT DSC8P	Practical/Lab Course BOT DSC 8P	Practical	1
		BOT DSE 8	Cytogenetics	Theory	4
		BOT DSE 9	Ecology	Theory	4
		BOT DSE 10	Plant System Physiology	Theory	4
		BOT GE 9	Methods in Plant Biology and their applications	Theory	4
		BOT GE 10	Traditional Knowledge System	Theory	4
			Dissertation/Academic Project/ Entrepreneurship	Theory/ Practical	6

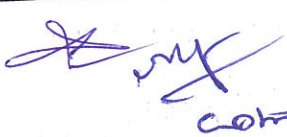
Master's in Botany					
FIFTH YEAR	IX	BOT DSC9	Plant Resource Utilization and Conservation	Theory	3
		BOT DSC9P	Practical/Lab Course BOT DSC 9P	Practical	1
		BOT DSE 11	Evolutionary Biology of Plants	Theory	4
		BOT DSE 12	Plant Pathology	Theory	4
		BOT DSE 13	Protected Agriculture: Hydroponics and Organic Cultivation	Theory	4
		BOT GE 11	Forest Ecology	Theory	4
		BOT GE 12	Herbarium Techniques	Theory	4
			Dissertation/Academic Project/ Entrepreneurship	Theory/ Practical	6
	X	BOT DSC10	Environmental Monitoring and	Theory	3

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		Ecological Restoration		
	BOT DSC10P	Practical/Lab Course BOT DSC 10P	Practical	1
	BOT DSE 14	Bioinformatics and Bio-safety norms	Theory	4
	BOT DSE 15	Advances in Plant Taxonomy	Theory	4
	BOT DSE 16	Plant Breeding	Theory	4
	BOT GE 13	Lichenology	Theory	4
	BOT GE 14	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					
FIRST YEAR	I	BOTSEC-MC-1	Mushroom Cultivation-I	Theory	1
		BOTSEC-MC-1P	Practical/Lab Course BOTSEC-MC-1P	Practical	1
	II	BOTSEC-MC-2	Mushroom Cultivation-II	Theory	1
		BOTSEC-MC-2P	Practical/Lab Course BOTSEC-MC-2P	Practical	1
Undergraduate Diploma in Botany					
SECOND YEAR	III	BOTSEC-MC-3	Mushroom Cultivation-III	Theory	1
		BOTSEC-MC-3P	Practical/Lab Course BOTSEC-MC-3P	Practical	1
	IV	BOTSEC-MC-4	Mushroom Cultivation-IV	Theory	1
		BOTSEC-MC-4P	Practical/Lab Course BOTSEC-MC-4P	Practical	1





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Bachelor in Botany					
THIRD YEAR	V	BOTSEC-MC-5	Mushroom Cultivation-V	Theory	1
		BOTSEC-MC-5P	Practical/Lab Course BOTSEC-MC-5P	Practical	1
	VI	BOTSEC-MC-6	Mushroom Cultivation-VI	Theory	1
		BOTSEC-MC-6P	Practical/Lab Course BOTSEC-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					
FIRST YEAR	I	BOTSEC-H-1	Hydroponics-I	Theory	1
		BOTSEC-H-1P	Practical/Lab Course BOTSEC-H-1P	Practical	1
	II	BOTSEC-H-2	Hydroponics -II	Theory	1
		BOTSEC-H-2P	Practical/Lab Course BOTSEC-H-2P	Practical	1
Undergraduate Diploma in Botany					
SECOND YEAR	III	BOTSEC-H-3	Hydroponics-III	Theory	1
		BOTSEC-H-3P	Practical/Lab Course BOTSEC-H-3P	Practical	1
	IV	BOTSEC-H-4	Hydroponics-IV	Theory	1
		BOTSEC-H-4P	Practical/Lab Course BOTSEC-H-4P	Practical	1
Bachelor in Botany					
THIRD YEAR	V	BOTSEC-H-5	Hydroponics-V	Theory	1
		BOTSEC-H-5P	Practical/Lab Course BOTSEC-H-5P	Practical	1
	VI	BOTSEC-H-6	Hydroponics -VI	Theory	1
		BOTSEC-H-6P	Practical/Lab Course BOTSEC-H-6P	Practical	1

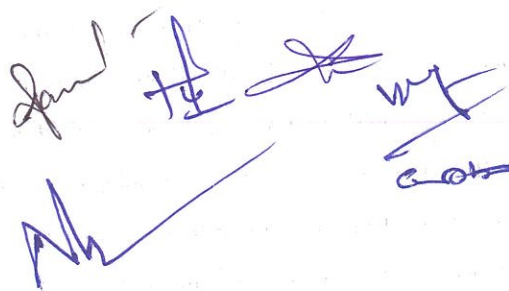
List of Skill Enhancement Courses Papers (SEC) with Semester Wise Titles for 'Botany'					
Year	Semester	Course	Paper Title	Theory/ Practical	Credits
Undergraduate Certificate in Botany					
FIRST YEAR	I	BOTSEC-NF-1	Nursery Development and Floriculture-I	Theory	1
		BOTSEC-NF-1P	Practical/Lab Course BOTSEC-NF-1P	Practical	1
	II	BOTSEC-NF-2	Nursery Development and Floriculture-II	Theory	1
		BOTSEC-NF-2P	Practical/Lab Course BOTSEC-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/Lab Course BOTSEC-NF-3P	Practical	1
	IV	BOTSEC-NF-4	Nursery Development and Floriculture-IV	Theory	1
		BOTSEC-NF-4P	Practical/Lab Course BOTSEC-NF-4P	Practical	1
Bachelor in Botany					
THIRD YEAR	V	BOTSEC-NF-5	Nursery Development and Floriculture -V	Theory	1
		BOTSEC-NF-5P	Practical/Lab Course BOTSEC-NF-5P	Practical	1
	VI	BOTSEC-NF-6	Nursery Development and Floriculture -VI	Theory	1
		BOTSEC-NF-6P	Practical/Lab Course BOTSEC-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.



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 to understanding herbarium techniques.

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Department of Botany

Semester-I

DISCIPLINE SPECIFIC COURSE (DSC)- Plant Diversity I (Microbes, Fungi and Algae)

No. of Hours: 75

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 diversity I (Microbes, Fungi and Algae)	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE CERTIFICATE IN BOTANY

Programme : <i>Undergraduate Certificate in Botany</i>	Year: I	Semester: I
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Subject: Botany

Course: BOT
DSC 1

Course Title: Plant diversity I (Microbes, Fungi and Algae)

Course Outcomes:

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

1. Develop an understanding about the classification and diversity of different microbes Algae, Fungi & Lichens & their economic importance.
2. Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.
3. Gain knowledge about developing commercial enterprise of microbial products.
4. Learn about the host-pathogen relationship and disease management.
5. Gain Knowledge about uses of microbes in various fields.
6. Understand the structure and reproduction of certain selected bacteria algae, fungi and lichens
7. Gain insight into the structure and replication mechanisms of viruses.



Semester-II

Undergraduate Certificate in Botany

DISCIPLINE SPECIFIC COURSE (DSC)- Plant Diversity II (Bryophyta, Pteridophyta and Gymnosperms)

No. of Hours-75

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 Diversity II (Bryophyta, Pteridophyta and Gymnosperms)	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE CERTIFICATE IN BOTANY

Programme : Undergraduate Certificate in Botany

Year: I

Semester:II

Subject: Botany

Course: BOT
DSC 2

Course Title: Plant Diversity II (Bryophyta, Pteridophyta and Gymnosperms)

Course Outcomes:

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

1. Develop a critical understanding of the morphology, anatomy and reproduction of Bryophyta, Pteridophyta and Gymnosperms.
2. Understand plant evolution and their transition to land habitat.
3. Learn the major patterns of diversity among plants, and the characters and types of data used to classify them.
4. Compare different approaches of classification.

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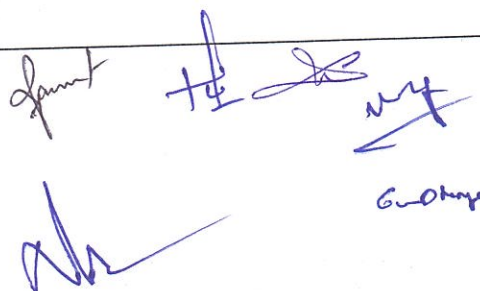
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Credits: 4	Discipline Specific Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (45)
1	General characteristics, ecological and economic importance of bryophytes, pteridophytes and gymnosperms.	9
2	Classification of Bryophyta (G. M. Smith); Morphology, anatomy and reproduction of <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> .	12
3	Classification of Pteridophyta (K. R. Sporne); Morphology, anatomy and reproduction of <i>Selaginella</i> , <i>Equisetum</i> and <i>Pteris</i> ; heterospory and seed habit, stelar evolution, telome theory.	12
4	Classification of Gymnosperm (K. R. Sporne); Morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> , <i>Ginkgo</i> and <i>Ephedra</i> .	12

Practical/Lab Course BOT DSC 2P

Unit	Topic	No. of Hours (30)
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Unit	Topic	No. of Hours (45)
1	An overview of cells and cell theories, prokaryotic and eukaryotic cells, cell organelles (nucleus, mitochondria, chloroplast, ER, golgi body, lysosomes, peroxisomes, glyoxysomes), nucleus, chromatin, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure, cell membrane and cell wall; models of plasma/cell membrane. Cell cycle and cell division (overview of mitosis and meiosis). Eukaryotic chromosome: structure, composition, karyotype analysis. Structure and function of Polytene and Lampbrush chromosomes.	15
2	Brief life history of Mendel, laws of Inheritance, chromosomal theory of inheritance, modified Mendelian ratio, lethal genes, co-dominance, incomplete dominance, multiple allelism, pleiotropic gene, sex-determination and sex-linked inheritance, cytoplasmic inheritance.	10
3	Linkage: concept and history, complete and incomplete linkage, Bridges experiment, Crossing over: Concept and significance, cytological proof of crossing over, mutations and chromosomal aberrations (types of mutations, effects of physical and chemical mutagens, numerical chromosomal changes: (euploidy, polyploidy and aneuploidy); structural chromosomal changes: (deletions, duplications, inversions and translocations).	10
4	Introduction to Biotechnology: Role in modern life, history and ethical issues associated with Biotechnology. Recombinant DNA Technology, enzymes and vectors involved in genetic engineering, gene cloning.	10

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1	<i>Marchantia, Anthoceros</i>: Morphology of thallus, rhizoids and scales, V.S. thallus through gemma cup, gemmae whole mount (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte through slides. <i>Funaria</i>- Morphology, whole mount leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and W.M. protonema.	10
2	<i>Selaginella</i>: Morphology, whole mount leaf with ligule, strobilus, microsporophyll and megasporophyll (temporary slides), T.S. stem, L.S. strobilus (permanent slide). <i>Equisetum</i>: Morphology, T.S. of internode, L.S. of strobilus and T.S. strobilus, whole mount sporangiophore, spores (wet and dry) (temporary slides); T.S. rhizome through permanent slides. <i>Pteris</i>: Morphology and anatomical features of rachis, rhizome and sporophyll through permanent slides.	10
3	<i>Cycas</i>: Morphology (coralloid roots, bulbil, leaf), T.S. coralloid root and rachis, V.S. leaflet and microsporophyll, whole mount spores (temporary slides), L.S. of ovule, T.S. of root (permanent slide). <i>Pinus</i>: Morphology (long and dwarf shoots, male and female cones), T.S. Needle and stem, L.S./T.S. of male cone, whole mount microsporophyll and microspores (temporary slides), L.S. of female cone, T.L.S. and R.L.S. stem (permanent slide).	10

Suggested readings

- Pandey, B.P. (2014). Modern Practical Botany Vol. II. S. Chand and Company Ltd., New Delhi.
- Bendre, A.M. and Kumar A. (2003). Manual of Practical Botany Vol. II. Rastogi Publications, Meerut.
- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Gangulee H.C., Kar, A.K. and Santra S.C. (2011). College Botany Vol II. 4th Edition New Central Book Agency.
- Kaur I.D., Uniyal P.L. (2019). Text Book of Gymnosperms. New Delhi, Delhi: Daya Publishing House.
- Kaur I.D., Uniyal P.L. (2019). Text Book of Bryophytes. New Delhi, Delhi: Daya Publishing House.
- Pandey, B.P. (2010). College Botany Vol II. S. Chand and Company Ltd., New

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

Unit	Topic	No. of Hours (45)
1	General characteristics, habitat, ecology and economic importance of microbes, fungi and algae.	9
2	Viruses-discovery, general structure, replication (general account), Lytic and lysogenic cycle, DNA virus (T-phage), RNA virus (TMV). Bacteria-discovery, general characteristics, cell structure, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).	12
3	Range of somatic thallus organization, cell wall composition, nutrition, reproduction and classification of fungi (G.C. Ainsworth); life cycle of <i>Albugo</i> (Mastigomycota) <i>Rhizopus</i> (Zygomycota) <i>Penicillium</i> (Ascomycota), <i>Puccinia</i> , <i>Agaricus</i> (Basidiomycota); <i>Alternaria</i> (Deuteromycota), General account of lichen and mycorrhiza.	12
4	Range of thallus organization, reproduction and classification of algae (F. E. Fritsch); morphology and life-cycles of: <i>Nostoc</i> , <i>Chlamydomonas</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> and <i>Sargassum</i> .	12

Practical/Lab Course BOT DSC 1P

Unit	Topic	No. of Hours (30)
1	EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle. Types of Bacteria from temporary/permanent slides/photographs; EM of bacterium; Binary Fission; Conjugation; Structure of root nodule; Gram staining technique.	6

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2	Salient features of families; Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Orchidaceae and Poaceae.	10
3	Pollination, structure of anther and pollen, development of male and female gametophytes, types of ovule, types of embryosac, double fertilization, polyembryoni, Apomixis and Aposory, . Endosperm; types of endosperm, dicot and monocot embryo.	10
4	Types of tissues; root and shoot apical meristems, simple, complex and secretory tissues, RAM and SAM theories. Structure of dicot and monocot root, stem and leaf, root-stem transition, vascular tissue and secondary growth, abnormal or anomalous secondary growth.	10

Practical/Lab Course BOT DSC 3P

Unit	Topic	No. of Hours (30)
1	Taxonomic Identification: Description of an angiospermic plant (one plant per family), study of vegetative and floral characters (description, V.S. of flower, section of ovary, floral diagram/s, floral formula/e) and systematic position of the following families (Ranunculaceae, Malvaceae, Fabaceae, Asteraceae, Solanaceae and Poaceae) according to Bentham and Hooker's system of classification.	10
2	Herbarium techniques: Plant collection, preservation and mounting of two properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book), digital/virtual herbarium.	5
3	Structure of anther (young and mature). Types of ovule, types of placentation. Female gametophyte: Polygonum (monosporic) type of embryo sac development (permanent slide/photograph), Pollination types and seed dispersal mechanism (photograph and specimens).	8
4	Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma), complex and secretory tissues. Anatomy of monocot and dicot stem leaf and root. Anomalous secondary growth (<i>Dracaena</i> , <i>Nyctanthus</i>).	7

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Suggested readings

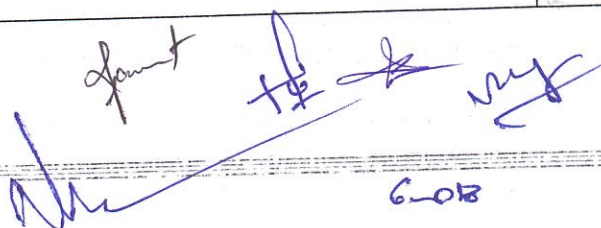
- Angiosperm Phylogeny Group (APG-2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1-20.
- Beck, C.B. (2010). An Introduction to Plant Structure and Development, II edition.
- Bhatnagar S.P, Dantu, P.K. Bhojwani S.S. (2018). The embryology of Angiosperms. Vikas Publ. House. New Delhi.
- Bhojwani, S.S. and Bhatnagar, S.P. (2010). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
- Johri, B.M. (1984). Embryology of Angiosperms. Springer-Verlag, Berlin.
- Leins, P., Tucker, S.C. and Endress, P.K. (1988). Aspects of floral development. J. Cramer. Germany.
- Maheshwari, P. (1971). An Introduction to Embryology of Angiosperms. McGraw Hill Book Co. London.
- Pandey, B.P. (2001) Plant Anatomy. S. Chand and Company Ltd., New Delhi.
- Raghwan, (1997). Molecular embryology of flowering plants. Cambridge Univ. Press. Cambridge.
- Sharma, M.K. (2013) Plant Structures (An Introduction to Plant Anatomy). Vayu Education of India.
- Sambamurty, A.V.S.S. (2010). Taxonomy of Angiosperms. I.K. International Pvt. Ltd.
- Saxena N.B. and Saxena S. (2012). Plant Taxonomy Pragati Prakashan.
- Sharma O.P. (2013). Plant Taxonomy. MC GRAW HILL INDIA.
- Sharma, P.C. (2017). Text Book of Plant Anatomy. Arjun Publishing House.
- Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Science Publishers. Verlag.
- Pandey, B.P. (2014). Modern Practical Botany Vol. II. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Pandey, B.P. (2001). Plant Anatomy. S. Chand and Company Ltd., Ram Nagar, New Delhi.
- Sundara, R.S. (2002). Practical Manual Anatomy and Embryology. Anmol Publisher, New Delhi.

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Subject: Botany			
Course: BOT DSC 3	Course Title: Plant Systematics and Developmental Biology (Angiosperm, Embryology and Anatomy)		
Course Outcomes: After the completion of the course the students will be able to: 1. Learn the major patterns of diversity among plants, and the characters and types of data used to classify plants. 2. Compare the different approaches of classification with regard to the analysis of data. 3. Become familiar with major taxa and their identifying characteristics, and to develop indepth knowledge of the current taxonomy of major plant families. 4. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications. 5. Understand plant morphology, anatomy and embryology. 6. Understand the role of tissues in plant functions. 7. Understand the composition, modifications, internal structure and architecture of plants. 8. Understand reproduction and developmental changes in plants.			

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

Unit	Topic	No. of Hours (45)
1	Identification, classification, nomenclature of plants, functions of herbarium, overview of important herbaria and botanical gardens of the India and world. Important floras, botanical nomenclature [principles and rules (ICN)]; ranks and names, binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations). Classification: Types of classification-artificial, natural and phylogenetic, Bentham and Hooker's (up to series), Hutchinson's classification and Angiosperm Phylogeny Group (APG IV) classification.	15



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2	Study of vegetative and reproductive structures of <i>Nostoc</i> , <i>Chlamydomonas</i> (electron micrographs), <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> and <i>Sargassum</i> through temporary preparations and permanent slides/specimens.	10
3	<i>Rhizopus</i> and <i>Penicillium</i> : Asexual stages from temporary mounts. <i>Alternaria</i> : Specimens/photographs and tease mounts. <i>Puccinia</i> : Herbarium specimens of Black Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on wheat and permanent slides of both the hosts. <i>Agaricus</i> : Specimens of button stage and full grown mushroom.	10
4	Lichens: Study of growth forms of lichens (crustose, foliose and fruticose). Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs).	4

Suggested readings

- Sambamurty, A.V.S.S. (2006). A text book of Algae. I.K International Publishing House,Pvt. Ltd.
- Barsanti, L. and Gualtieri, P. (2014). Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition. CRC/ Taylor & Francis, NY.
- Lee, R.E. (2018). Phycology, Fifth Edition. Cambridge University Press, Cambridge.
- Marjorie, Kelly and Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw Hill New York, 5th edition.
- Pandey, S.N and Trivedi, P.S. (2015). A text book of Botany Vol.I Vikas publishingHouse Pvt/ Ltd, New Delhi.
- Mehrotra, R.S. and K.R. Aneja. (1999). An Introduction to Mycology. New Age International Publisher.
- Pelczar M.J., Chan E.C.S and Kreig N.R. (1997). Microbiology. Tata MacGraw Hill.
- Robert Edward Lee. (2018). Phycology. Cambridge University Press, U.K. 5th edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, MacMillanPublishers Pvt. Ltd., Delhi.
- Sharma, O. P. (2011). Algae. Tata McGraw Hill Education Private Limited, U.K. 1st edition.
- Webster, J. and Weber, R. (2007). Introduction to Fungi. Third Edition. Cambridge UniversityPress. Cambridge and New York.
- Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 11th Edition, McGraw-Hill, USA.
- Purohit, S.D., Kundra, G. K. and Singhvi, A. (2013). Practical Botany (part I). ApexPublishing House Durga Nursery Road Udaipur, Rajasthan

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Delhi, India.

- Parihar, N.S. (1976). Biology and Morphology of Pteridophytes. Central Book Depot.
- Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
- Sharma, O.P. (1990). Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
- The Pteridophyte Phylogeny Group (PPG Classification) (2016): A community-derived classification for extant lycophytes and ferns. Journal of Systematics and Evolution. 54(6): 563-603. Doi:10.1111/jse.12229.
- Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Bryophyta, S. Chand. Delhi, India.
- Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Gymnosperms, S. Chand and Company Ltd., Ramnagar, New Delhi, India.

Semester-III

Undergraduate Diploma in Botany

No. of Hours- 75

DISCIPLINE SPECIFIC COURSE (DSC)- Plant Systematics and Developmental Biology (Angiosperm, Embryology and Anatomy)

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 Systematics and Developmental Biology (Taxonomy, Embryology and Anatomy)	4	3	0	1	Undergraduate certificate in Botany	Nil

UNDERGRADUATE DIPLOMA IN BOTANY

Programme : <i>Undergraduate Diploma in Botany</i>	Year: II	Semester: III
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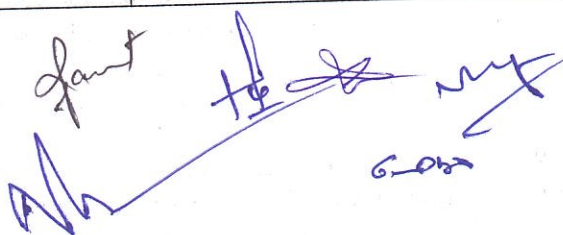
Semester-IV**Undergraduate Diploma in Botany****No. of Hours- 75****DISCIPLINE SPECIFIC COURSE (DSC)- Cytology, Genetics and Biotechnology****CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Cytology, Genetics and Biotechnology	4	3	0	1	Undergraduate certificate in Botany	

UNDERGRADUATE DIPLOMA IN BOTANY**Programme : Undergraduate Diploma in Botany****Year: II****Semester: IV****Subject: Botany****Course: BOT
DSC 4****Course Title: Cytology, Genetics and Biotechnology****Course Outcomes:**

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

1. Understand the structure and chemical composition of chromatin and concept of cell division.
2. Interpret the Mendel's principles; acquire knowledge of cytoplasmic inheritance and sex- linked inheritance.
3. Understand cell structure, nucleic acids, organization of DNA in prokaryotes and eukaryotes, DNA replication mechanism, genetic code and transcription process.
4. Understand the basic tools and techniques used in Plant tissue culture.

Credits:**Discipline Specific Course****Max. Marks: As per Univ. rules****Min. Passing Marks: As per Univ. rules**

Practical/Lab Course BOT DSC 4P

Unit	Topic	No. of Hours (30)
1	Structure of prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs. Study of the photomicrographs of cell organelles, structure of plant cell through temporary mounts. Study of mitosis and meiosis (temporary mounts and permanent slides).	8
2	Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square. Monohybrid cross (dominance and incomplete dominance) Dihybrid cross and gene interactions.	10
3	Study of polyploidy in plants. Photographs/permanent slides showing translocation ring, laggards and inversion bridge.	5
4	Contribution of G. J. Mendel, H. G. Khurana, Watson and Crick, Griffith, Harshey and Chase, Kary Mullis. Instruments used in Biotechnology.	7

Suggested readings

- 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.
- Berk, A., Kaiser, C.A., Lodish, H., Amon, A., Ploegh, H, Bretscher (Author), Monty Krieger, A., Martin, K.C. (Eds). (2016) Molecular Cell Biology. Freeman & Co., USA.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
- Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991). Principles of Genetics, John Wiley & Sons.
- Rastogi, V.B. (2019). Genetics. 4th Edition. MEDTECH: A Division of Scientific International.
- Russel P. J. (2010). Genetics-A Molecular Approach, Pearson Education Inc.
- Singh R. J. (2002). Plant Cytogenetics, CRC Press
- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- Singh, R.J. (2021). Practical Manual on Plant Cytogenetics. CRC Press, Taylor and Francis Group, Routledge.

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Semester-V

Bachelor of Science in Botany

No. of Hours-75

DISCIPLINE SPECIFIC COURSE (DSC)- Plant Physiology and Biochemistry

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 Physiology and Biochemistry	4	3	0	1	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 DSC 5	Course Title: Plant Physiology and Biochemistry		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the role of physiological and metabolic processes for plant growth and development. 2. Learn the symptoms of mineral deficiencies in crops and their management. 3. Assimilate knowledge about the biochemical composition of plant diversity. 4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants.			

Credits: 1	Discipline Specific Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

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Unit	Topic	No. of Hours (45)
1	Plant water relations, water potential and its components, diffusion and osmosis, transpiration and its significance, factors affecting transpiration, root pressure and guttation. Mineral nutrition: Essential elements, macro and micronutrients; criteria of essentiality of elements, role of essential elements; transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.	12
2	Photosynthesis: photosynthetic Pigments (Chl a, b, xanthophylls, carotene), photosystem I and II, electron transport and mechanism of ATP synthesis, C ₃ , C ₄ and CAM pathways of carbon fixation, photorespiration. Respiration: glycolysis, anaerobic respiration, TCA cycle, oxidative phosphorylation and glyoxylate cycle.	13
3	Biological nitrogen fixation, nitrate and ammonia assimilation Plant growth regulators: discovery and physiological roles of auxins, gibberellins, cytokinins, abscisic acid and ethylene. Introduction to plant morphogenesis: phytochrome and cryptochrome mediated photoreceptors.	10
4	General introduction to carbohydrates, lipids and proteins. Enzymes (structure and properties, mechanism of enzyme catalysis and enzyme inhibition (competitive & non-competitive), factors affecting enzyme action), Michaelis-Menten kinetics.	10

Practical/Lab Course BOT DSC 5P

Unit	Topic	No. of Hours (30)
1	Demonstration of process of diffusion, osmosis and plasmolysis. Demonstration of transpiration in dorsiventral leaf by four leaf and cobalt chloride method. Determination of rate of transpiration by Ganong's/Farmer's potometer.	10

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2	Demonstration of the effect of light intensity and bicarbonate concentration on O ₂ evolution in photosynthesis by Wilmott's bubbler Determination of R.Q. of different respiratory substrates by Ganong's respirometer. Demonstration of anaerobic respiration in germinating seeds.	14
3	Test of carbohydrates, proteins and fats.	6

Suggested Readings

- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
- Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
- Davies P J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition.
- Nelson, D.L., and Cox, M.M. (2008). *Lehninger Principles of Biochemistry* (5th ed.). W.H. Freeman & Co., New York.
- Taiz, L., Zeiger, E., (2014). Plant Physiology. Sinauer Associates Inc., U.S.A. 6th Edition
- Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.

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Semester-VI**Bachelor of Science in Botany****No. of hours-75****DISCIPLINE SPECIFIC COURSE (DSC)- Plant Ecology and Biostatistics****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 Ecology and Biostatistics	4	3	0	1	Undergraduate diploma in Botany	Nil

BACHELOR OF SCIENCE IN BOTANY		
Programme : <i>Bachelor of Science in Botany</i>		Year: III
Semester: VI		
Subject: Botany		
Course: BOT DSC 6	Plant Ecology and Biostatistics	
Course Outcomes: After the completion of the course the students will be able to: 1. Acquaint with complex interrelationship between organisms and environment; 2. Understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography. 3. Understand the strategies for sustainable natural resource management and biodiversity conservation.		

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4. Develop practical knowledge of the different statistical tools and techniques.	
Credits: 4	Discipline Specific Course
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours (45)
1	Plant adaptation in relation to water (Hydrophytes and xerophytes), light (Sciophytes and heliophytes) and temperature. Pollution: air, water, soil and radioactive.	12
2	Ecosystem: Types, structure, energy flow, trophic organization, food chains and food webs, ecological pyramids, ecological factors and ecosystem productivity. Biogeochemical cycles: Cycling of carbon, nitrogen and phosphorous.	12
3	Population: Characteristics, Growth curves, Ecotypes and Ecads, Plant communities: Characteristics, plant succession, biological spectrum.	9
4	Definition and scope of statistics, sampling techniques, representation of grouped and ungrouped data. Measures of dispersion: range, mean deviation, variation, standard deviation; Chi-square test, regression analysis. Measures of central tendency: Arithmetic mean, mode, median.	12

Practical/Lab Course BOT DSC 6P

Unit	Topic	No. of Hours (30)
1	Observation and study of different ecosystems mentioned in the syllabus. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, rain gauge and lux meter. Determination of pH, and analysis of soil samples for soil moisture,	10

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	organic carbon, nitrogen and phosphorus.	
2	Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats. Study of ecological adaptations in hydrophytes and xerophytes. Study of biotic interactions of stem parasite (<i>Cuscuta</i>), root parasite (<i>Orobancha</i>), epiphytes, predation (insectivorous plants) through specimen or diagrams.	8
3	Determination of minimum quadrat size for the study of herbaceous vegetation by species area curve method (species to be listed). Quantitative analysis of herbaceous vegetation in the college campus for frequency, density, abundance and A/F ratio. Population structure of dominant tree species of the locality.	8
4	Analysis of statistical data: mean, median and mode by analyzing the given data of individual, discrete and continuous series, standard deviation and standard error.	4

Suggested readings

- Banerjee, P.K. (2006). Introduction to Biostatistics. S. Chand and Company Ltd., RamNagar, New Delhi.
- Chapman, J.L. and Reiss, M.J. (2003). Ecology: Principles and Applications. Second Edition. Cambridge University Press, UK. ISBN 0 521 58802 2. 335 pages.
- Khan, I.A., Khanum, A., Khan S., (2020). Fundamentals of Biostatistics, 6th edition. Ukaaz Publications, Hyderabad, India.
- Odum, E.P. (2011). Fundamental of Ecology. 5th Edition. Saunders. ISBN 9780030584145. 613 pages.
- Rastogi, V.B. (2015). Biostatistics. Medtech, 3rd Edition.
- Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
- Shukla, R.S. and Chandel P.S. (2005). A text book of Plant Ecology. S. Chand and Company Ltd., Ram Nagar, New Delhi.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.

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

Semester VII

DISCIPLINE SPECIFIC COURSE (DSC) – CRYPTOGRAMS

No. of Hours-75

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		
CRYPTOGAMS	4	3	0	1	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 DSC7	Course Title: Cryptogams		
Course Outcomes: After the completion of the course the students will be able to: 1. Develop understanding about the diversity of different algae, fungi, bryophytes and pteridophytes. 2. Understand the origin, diversity, evolution, different classificatory systems of cryptogams. 3. Develop conceptual skill about identifying various cryptogams. 4. Understand the general characteristics and life cycle of different groups of algae, fungi, bryophytes and pteridophytes. 5. Gain knowledge about the uses of algae, fungi, bryophytes and pteridophytes in various fields.			
Credits: 4		Discipline Specific Course	

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Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours (45)
1	General characteristics, pigmentation and economic importance of Algae; Classification of Algae (G. M. Smith) Salient features of Cyanophyta, Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta.	10
2	General characteristics and economic importance of Fungi, Heterothallism, Para sexuality and Heterokaryosis. Classification of Fungi (G.C. Ainsworth), Recent trends in classification of fungi Salient features of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina.	15
3	General characteristics and economic importance of Bryophytes, Evolution of Sporophytes, Classification of Bryophytes (Schuter and Riemer) Salient features of Hepatocopsida, Anthocerotopsida and Bryopsida.	10
4	General characteristics and economic importance of Pteridophytes, Stealer system, Telome theory, heterospory and homospority, seed habit, evolution of sorus, classification of Pteridophytes (K. R. Sporne) and PPG system. Salient features of Psilophytopsida, Lycopodiopsida, Sphenopsida, Polypodiopsida.	10

Practical/Lab Course BOT DSC 7P

Unit	Topic	No. of Hours (30)
1	To study and identify the following algal material by preparing the temporary slides: <i>Sytonema</i> , <i>Chlamydomonas</i> , <i>Eudorina</i> , <i>Tetraspora</i> , <i>Hydrodictyon</i> , <i>Oedogonium</i> , <i>Sargassum</i> , <i>Chara</i> , <i>Gelidium</i> including	6

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	some genera available at local level.	
2	Study of working principle of various instruments used in Mycology laboratory. Preparation of media and isolation of fungi from different substrates. Study of Mycorrhizae: Ectomycorrhiza and Endomycorrhiza through photographs. To study and identify the following fungi by preparing the temporary slides: <i>Albugo</i> , <i>Rhizopus</i> , <i>Penicillium</i> , <i>Puccinia</i> , <i>Alternaria</i> , <i>Agaricus</i> : Specimens of button stage and mature basidiocarp	8
3	Study of general habit, external and internal morphology of vegetative and reproductive features of the bryophytes (<i>Marchantia</i> , <i>Plagiochasma</i> , <i>Asterella</i> , <i>Cryptomitrium</i> , <i>Targionia</i> , <i>Conocephalum</i> , <i>Frullania</i> , <i>Porella</i> , <i>Anthoceros</i> , <i>Notothylas</i> , <i>Sphagnum</i> , <i>Polytrichum</i>)	6
4	<i>Lycopodium</i> : L.S. of cone <i>Selaginella</i> : Morphology, whole mount leaf with ligule, strobilus, microsporophyll and megasporophyll (temporary slides), T.S. stem, L.S. strobilus (permanent slide). <i>Equisetum</i> : Morphology, T.S. internode, T.S. and L.S. Strobilus, whole mount sporangiophore, spores (wet and dry) (temporary slides); T.S. rhizome (permanent slide). <i>Psilotum</i> , <i>Azolla</i> , <i>Marsilea</i> : Rhizome Morphology of <i>Adiantum</i> and <i>Botrychium</i> T.S. of fern sori/sporophyll	10

Suggested readings

- Alexopoulos, C.J. and Mims C.W. (1995). Introductory Mycology. John Wiley and Sons. New York. Fourth Edition.
- Sambamurty, A.V.S.S. (2006). A text book of Algae. I.K International Publishing House, Pvt. Ltd.
- Barsanti, L. and Gualtieri, P. (2014). Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition. CRC/ Taylor & Francis, NY.
- Lee, R.E. (2018). Phycology, Fifth Edition. Cambridge University Press, Cambridge.
- Marjorie, Kelly and Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw Hill New York, 5th edition.
- Pandey, S.N and Trivedi, P.S. (2015). A text book of Botany Vol.I Vikas

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- publishingHouse Pvt/ Ltd, New Delhi.
- Mehrotra, R.S. and K.R. Aneja. (1999). An Introduction to Mycology. New Age International Publisher.
 - Pelczar M.J., Chan E.C.S and Kreig N.R. (1997). Microbiology. Tata MacGraw Hill.
 - Robert Edward Lee. (2018). Phycology. Cambridge University Press, U.K. 5th edition.
 - Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, MacMillanPublishers Pvt. Ltd., Delhi.
 - Sharma, O. P. (2011). Algae. Tata McGraw Hill Education Private Limited, U.K. 1st edition.
 - Webster, J. and Weber, R. (2007). Introduction to Fungi. Third Edition. Cambridge UniversityPress. Cambridge and New York.
 - Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 11th Edition, McGraw-Hill, USA.
 - Kaur I.D., Uniyal P.L. (2019). Text Book of Bryophytes. New Delhi, Delhi: Daya Publishing House.
 - Pandey, B.P. (2010). College Botany Vol II. S. Chand and Company Ltd., New Delhi, India.
 - Parihar, N.S. (1976). Biology and Morphology of Pteridophytes. Central Book Depot.

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Semester VIII

DISCIPLINE SPECIFIC COURSE (DSC) – PHANEROGAMS

No. of Hours- 75

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		
Phanerogams	4	3	0	1	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 DSC 8	Course Title: Phanerogams		
Course outcomes: After the completion of the course the students will be able to:			
1. Understand about the diversity and general characteristics of Gymnosperms and Angiosperms. 2. Understand the different classificatory systems of Gymnosperms and Angiosperms. 3. Understand the morphology, anatomy and reproduction of different groups of Gymnosperms. 4. Understands description, Identification, Nomenclature and classification of plants. 5. Study the characteristic features and economic importance of some important families.			
Credits:	Discipline Specific Course		
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules		

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Unit	Topic	No. of Hours (45)
1	General Characteristics, and economic importance of gymnosperms, classification (K. R. Sporne).	10
2	Salient features of Cycadales, Coniferales, Ginkgoales, Ephedrales, Welwitschiales and Gnetales.	12
3	Important system of classification of Angiosperms; (Bentham & Hooker, J. Hutchinson and A. Takhtajan classification and their merits and demerits); APG system. Concept of ICBN and ICN. Important rules: rank, inorninal system, typification, author citation, valid publication, principle of priority and its limitations). A very brief account on International Code of Nomenclature of Cultivated Plants (ICNCP); The species concept; Taxonomic tools.	9
4	Distinguishing features only of the following families and their economic importance. Ranunculaceae, Rutaceae, Fabaceae, Rosaceae, Apiaceae, Asteraceae, Apocynaceae, Solanaceae, Lamiaceae, Orchidaceae, Liliaceae and Poaceae.	14

Practical/Lab Course BOT DSC 8 P

Unit	Topic	No. of Hours (30)
1	<i>Cycas</i> : Morphology (coralloid roots, bulbil, leaflet) T.S. coralloid root and achis, V.S. leaflet and microsporophyll, whole mount spores (temporary slides), L.S. of ovule, <i>Pinus</i> : Morphology (long and dwarf shoots, male and female cones), T.S. of needle and stem, L.S./T.S. of male cone, L.S. female cone, T.L.S. and R.L.S. stem (permanent slide), T.S. of spur (dwarf shoot).	6

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2	<i>Ginkgo</i> : Morphology (long and dwarf shoots), leaves, T.S. of rachis, T.S. of leaves. <i>Cupressus</i> : Morphology of leaves and seeds <i>Araucaria</i> : Morphology of leaves. <i>Taxus</i> : Morphology, T.S. of leaves. <i>Cedrus</i> : Morphology (long and dwarf shoots, male and female cones), T.S. of needle and stem.	6
3	To identify the flowering twigs of given families by studying the taxonomic characters using technical terms: At least two specimens from each family should be studied: Magnoliaceae, Myrtaceae, Scrophulariaceae, Verbenaceae, Loranaceae, Cannabaceae, Moraceae, Fagaceae, Orchidaceae, Zingiberaceae, Cyperaceae, Poaceae.	10
4	To study the vegetation type(s) and flora(s) of different local areas, and training in collection and preservation.	8

Suggested readings

- 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.
- Sharma O.P. (2013). Plant Taxonomy. Mc Graw hill India.
- 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.
- Gaur, R.D. (1999). Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.
- Vashishta, P.C., Sinha, A.K. and Kumar, A. (2012). Botany for degree students. Pteridophytes. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms New Age International, Pvt Ltd (P) New Delhi.
- Chamberlain, C.J. (1980) Gymnosperms Structure and Evolution. CBS Publishers and Distributors.
- Pant, D.D. and Osborne, R. and Birbal Sahni. (2002). An introduction to gymnosperms, cycas, and cycadales. Birbal Sahni Institute of Palaeobotany.

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Semester IX

DISCIPLINE SPECIFIC COURSE (DSC) – PLANT RESOURCE UTILIZATION AND CONSERVATION

No. of Hours-75

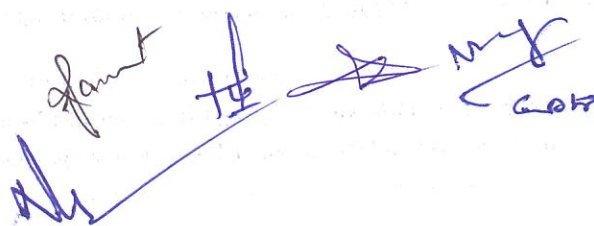
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Plant Resource Utilization and Conservation	4	3	0	1	Honours Degree in Botany	Nil

MASTER IN SCIENCE IN BOTANY

Programme : <i>Master in Science in Botany</i>		Year: V	Semester: IX
Subject: Botany			
Course: BOT DSC 9	Course Title: Plant Resource Utilization and Conservation		
Course outcomes: After the completion of the course the students will be able to: 1. Describe economically important plants with botanical names, family and uses. 2. Understand the various uses of plants; biodiversity status, loss and management strategies. 3. Understand the biogeography and initiatives for biodiversity conservation.			

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



Unit	Topic	No. of Hours (45)
1	Sustainable development: Basic concepts. Vavilov's centers of origin. World centers of primary diversity of domesticated plants: The Indo-Burmese centre plant introduction and secondary centers. Overview of (i) Food, forage and fodder crops. (ii) Fibre crops. (iii) Medicinal and aromatic Plants and (iv) Vegetable oil- yielding crops and their uses.	8
2	Important fire-wood and timber-yielding and non-timber forest products (NTFPs) such as bamboos, rattans, raw materials for paper-making, gums, tannins, dyes, resins and fruits. Lesser known plants of Uttarakhand and their economic importance; Wild edible plants of Uttarakhand. Green revolution: Benefits and adverse consequences. Plants used as avenue trees: for shade, pollution control and aesthetics. Principles of conservation: extinctions: environmental status of plants based on International Union for Conservation of Nature (IUCN).	12
3	Strategies for conservation- in-situ conservation: International efforts and Indian initiatives; Protected areas in India-with especial reference to Uttarakhand. sanctuaries, National Parks, biosphere reserves, wetlands, mangroves and coral reefs for the conservation on wild biodiversity.	10
4	Strategies for conservation- Ex-situ conservation: Principles and practices; botanical gardens, field gene banks, seed banks, in vitro repositories, cryo-banks, General account of the activities of botanical Survey of India (BSI), National Bureau of Plant Genetic resources (NBPGR), Indian Council of Agriculture Research (ICAR), Council of Scientific and Industrial Research (CSIR) and Department of Biotechnology (DBT) for conservation, non- formal conservation efforts.	15

Practical/Lab Course BOT DSC 9P

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Semester X

No. of Hours-75

DISCIPLINE SPECIFIC COURSE (DSC) – ENVIRONMENTAL MONITORING AND ECOLOGICAL RESTORATION

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		
Environmental Monitoring and Ecological Restoration	4	3	0	1	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: X
Subject: Botany			
Course: BOT DSC 10	Course Title: Environmental monitoring and ecological restoration		
Course Outcomes: After the completion of the course the students will be able to: 1. Understand and apply the basic concept of ecosystem and other sciences in environmental science 2. Analyse the relationship between ecology, ecosystem and environment			

Credits: 4		Discipline Specific Course	
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules	
Unit	Topic	No. of	

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		Hours (45)
1	Environment: Definition, major components and scope of environment science, Environmental impact assessment. Global environmental changes: Global warming, Drivers of climate change, Ozone layer depletion, green house gases and their sources, greenhouse effects, drivers of climate change, green house gases and their sources; Effects of increased CO₂ on plants; International efforts on climate change issues	11
2	Monitoring of atmospheric deposition: Causes and consequences of the excessive atmospheric deposition of nutrients and trace elements, Eutrophication ; Acid rain and its effect on plants, animals, microbes and ecosystems Bio-monitoring and bio-indication	10
3	Definition and concept of reclamation, remediation, restoration and rehabilitation Causes and impact of disturbances on the structure and functioning of terrestrial and aquatic ecosystems Degradation and restoration of natural ecosystems: Forests, grassland, wetlands	14
4	Restoration of degraded soils, restoration of contaminated soils and soil fertility Restoration of biological diversity: Augmentation, reintroduction and introduction of species	10

Practical/Lab Course BOT DSC 10P

Unit	Topic	No. of Hours (30)
1	Water and soil analysis: Introduction, sampling techniques and methods of collection of water and soil samples Analysis of physico- chemical characteristics of water and soil samples	10
2	Types of ecosystems and ecosystem services Approaches to and principles of restoration	5

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3	Assess and present methods, results, and interpretation of restoration activities Restoration plan based on examples of various ecosystems Develop a restoration and management plan for a local site	8
4	Case study examples, Field visit to restoration sites	7

Suggested readings

- Paul E Hardisty 2010. Environmental and economic sustainability CRC Press.
- S.C. Santra 2011. Environmental Science. New Central Book Agency.
- R.K. Sapru 1987. Environmental Management in India (Vol I & II). Ashish Publishing house
- Andel, J. and Aronson, J. (Eds). (2005). Restoration Ecology: The New Frontier. Blackwell Publishing
- Singh, J.S. Singh S.P. and Gupta, S.R. 2014. Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Govind Prasad 2012. Restoration and Conservation ecology. Discovery Publishing Pvt.Ltd; First Edition (1 January 2012)
- Andre F. Clewell and, James Aronson 2013. Ecological Restoration (Second Edition): Principles, Values, and Structure of an Emerging Profession. Part of: The Science and Practice of Ecological Restoration
- Kim Y.J. and Platt U. (Eds.) (2008) Advanced Environmental Monitoring, XXII, 420 p. Springer.
- Laboratory Analytical Techniques Series (LATS), published by CPCB.
- Roa M. (2008) Environmental Science Activities Kit, Jossey-Bas.
- Wagner T.P. and Robert S. (2009) Environmental Science: Active Learning Laboratories and Applied Problem Sets, 2nd Edition, Wiley.
- Wells E. (2009) Lab Manual for Environmental Science, Cengage Learning
- Case studies: Websites
- Journals: Environmental Management, Environmental Pollution, Environmental Science and Technology

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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 : <i>Undergraduate Certificate in Botany</i>		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	Plasmamembrane, 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

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

Programme : <i>Undergraduate Diploma in Botany</i>		Year: II	Semester: III
Subject: Botany			
Course: BOT GE 3	Plant Science – II		
Course Outcomes: After the completion of the course the students will be able to 1. Understand the basic biochemical and physiological process in plants. 2. Understand the fundamentals of plant tissue culture techniques used in molecular biology. 3. Understand the concept of biodiversity and its conservation. 4. Understand the concepts of plant breeding methods and crop evolution.			

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

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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 alternations 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.

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- 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 : <i>Bachelor of Science in Botany</i>		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.

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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: - Understand the global climate changes and global warming. - 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 foot print 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: Asper Univ. rules

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 & Metthaei 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 power point presentation	8

Suggested Readings

- Lodish, H., Berk, A., Zipursky, S.L. Maztsudaira, P., Baltimore, Dand Darnell, l. (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 Alkaloides Springer Verlag, Berlin
- Meister, A. (1965). Biochemistry of the Amino acids. 2vols. 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: BOT GE 9	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

Unit	Topic	No. of Hours (60)
1	Plants and 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 Immuno techniques Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry 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, Haward 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: BOT GE 10	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 <i>vis-a-vis</i> 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 Himalayi Sanskriti mein 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.tkdil.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

Programme : *Master of Science in Botany*

Year: V

Semester: IX

Subject: Botany

Course: BOT
GE 11

Course Title: Forest Ecology

Course Outcomes:

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

1. Understand the structure and function of forest ecosystem.
2. Understand methods for studying vegetation, community pattern and processes, ecosystem function, biodiversity, carbon stock and carbon sequestration.
3. Understand the students to understand the linkage between humans and forests.

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 Aspects of Forests: Forest ecology and forest ecosystems, Importance of forests in environmental conservation Primary Productivity and Detritus Pool; Formulations 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 Work Book. 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

Programme : *Master of Science in Botany*

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

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 Hand book 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
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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		
Lichenology	4	4	0	0	Botany in Honours Degree	Nil

MASTER OF SCIENCE IN BOTANY		
Programme : <i>Master of Science in Botany</i>		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). Hand book of lichens, Bishen Singh Mahendrapal Singh: Dehradun India.
- Awasthi, D.D. (2007). A compendium of the macrolichens of India, Nepal and Srilanka. Dehradun Bishen Singh Mahendra pal 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 : *Master of Science in Botany*

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

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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

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	Introduction to mushrooms and their economic importance Scope of mushroom cultivation in India Nutritional and medicinal value of mushrooms Important edible and medicinal mushrooms	15

Practical/Lab Course BOT SEC MC 1P

Unit	Topic	No. of Hours (30)
1	Field visit to the nearby area for identification of naturally growing mushroom species Collection techniques and preservation of mushrooms Introduction to laboratory equipment for mushroom cultivation Visit to mushroom cultivation laboratory/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 MC 2P

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 MC 3P

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

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

Practical/Lab Course BOT SEC MC 4P

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

Practical/Lab Course BOT SEC MC 5P

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

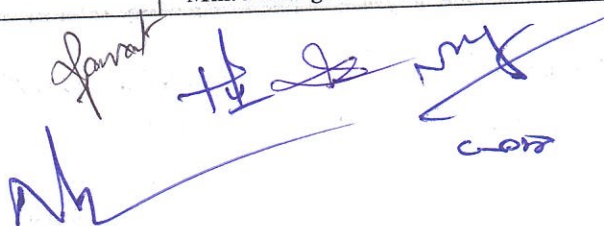
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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



Unit	Topic	No. of Hours (15)
1	Government schemes and subsidies in mushroom cultivation Cost-benefit analysis for setting a mushroom cultivation unit Marketing strategies for mushrooms Supply chain management for mushrooms	15

Practical/Lab Course BOT SEC MC 6P

Unit	Topic	No. of Hours (30)
1	Preparation of a business plan for mushroom farm Market survey on the demand of mushrooms Liaising with the mushroom's sellers/users (hostels, restaurants, vegetable sellers) Interactions with successful mushroom entrepreneurs	30

Suggested Readings

- Bahl, N. (2000). Hand book of Mushrooms. Oxford & Ibh Publishing Co. Pvt Ltd.
- 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 and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
- Tewari, P. and Kapoor, S.C. (1988). Mushroom cultivation, Mittal Publications, 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

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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 BOT SEC H 1P

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

Skill Enhancement Course: Hydroponics 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		
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 CO2 management Water and nutrient recirculation techniques Common pests and diseases in hydroponics and their management	15
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Practical/Lab Course BOT SEC H 3P

Unit	Topic	No. of Hours (30)
1	Designing and assembling a hydroponic 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
Subject: Botany		Semester: IV
Course: BOT SEC H 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 hydroponic system. Growth cycles and yield optimization Vertical farming techniques and urban hydroponics Organic hydroponics and sustainable practices	15

Practical/Lab Course BOT SEC H 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 hydroponic solutions	30

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	Intercropping and mixed cropping in hydroponics	
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	Skill Enhancement Course: Hydroponics V
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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 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 H 5	Hydroponics V		

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Credits: 2	Skill Enhancement Course
Max. Marks: As per Univ. rules	Min. Passing Marks: Asper 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 Hydroponic system Branding, marketing, and selling hydroponic produce Certification and regulatory guidelines for hydroponic produce	15

Practical/Lab Course BOT SEC H 5P

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
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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		

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Hydroponics 6	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 hydroponic system	30

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	Internship/industrial training in hydroponics	
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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



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 NF 1P	
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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 No. of Hours- 45
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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 Propagation Seed Propagation & Its Importance Vegetative Propagation (Cutting, Grafting, Layering) Micropropagation (Tissue Culture Basics) Role of Plant Growth Regulators Factors Affecting Plant Growth Hardening of plants in glass house, mist chamber etc.	15

Practical/Lab Course BOT NF 2P

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

Skill Enhancement Course: Nursery Development and Floriculture- 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		
Nursery Development and 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 a local commercial Nursery	30

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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	

Practical/Lab Course BOT SEC NF 4P

Unit	Topic	No. of Hours (30)
1	Growing Flowers in Open & Protected Conditions Designing Flower Beds & Lawns Flower Arrangement & Bouquet Making Greenhouse/Play house 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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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 BOT NF 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.

