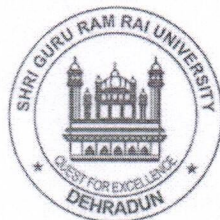


SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]



DEPARTMENT OF BOTANY SCHOOL OF BASIC & APPLIED SCIENCES SHRI GURU RAM RAI UNIVERSITY

Bachelor of Science OR Bachelor of Science (Hons. With Research) in Botany

Based on NEP 2020

[Exit Options after completion of 01 Year, 02 Years, 03 Years, and 04 Years]

Effective from Academic Session 2024-2025

Patel Nagar, Dehradun, Uttarakhand

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**Basic Structure of UG Multidisciplinary Programme (with Three Core Disciplines) –
B.Sc. in Life Sciences with Botany, Zoology, and Chemistry as core disciplines**

Type of Course

Discipline Specific Core (DSC)

Discipline Specific Elective (DSE)

General Elective (GE)

Ability Enhancement Courses (AEC)

Skill Enhancement Course (SEC)

Internship/Apprenticeship / Project/ Community Outreach (IAPC)

Value Addition course (VAC)

Sem	Core - Discipline Specific Core (DSC)	Elective- Discipline Specific Elective (DSE)	Elective- Generic Elective (GE)	Ability Enhancem ent Course (AEC)	Skill Enhancement Course (SEC)	(Internship /Apprentic eship / Project/ Community Outreach) (IAPC)	Value Addition Course (VAC)	Total credits
	Course/credit distribution (Credits 4) Theory or Theory + Practicum (3T+1L)	Course/ credit distribution (Credits 4) Theory or Theory + Practicum/ Lab (3T+1L or 2T+2L)	Course/ credit distribution (Credits 4) Theory or Theory + Practicum/ Lab (3T+1L or 2T+2L)	Course/ credit distribution (Credits 2)	Course/credit distribution (Credits 2)	Course/ credit distribution (Credits 2)	Course/ credit distribution (Credits 2)	22
I	DSC A(Botany) 1- (4) DSC B (Zoology) 1- (4) DSC C (Chemistry)1- (4) (3T+1L)	-	Choose one from a pool of courses GE – 1 (4)	AEC – 1 (2)	Choose one from a pool of SEC courses SEC – 1 (2)	-	Choose one from a pool of VAC courses VAC – 1 (2)	22
II	DSC A(Botany) 2- (4) DSC B (Zoology) 2- (4) DSC C (Chemistry)2- (4) (3T+1L)	-	Choose one from a pool of courses GE – 2 (4)	AEC – 2 (2)	Choose one from a pool of SEC courses SEC – 2 (2)	-	Choose one from a pool of VAC courses VAC – 2 (2)	22
Students on exit shall be awarded Undergraduate Certificate (in the field of Multidisciplinary study) after securing requisite 44 credits in semester I & II and vocational course of 4 credits (as per guidelines)								Total = 44

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III	DSC A(Botany) 3- (4) DSC B (Zoology) 3- (4) DSC C (Chemistry)3- (4) (3T+1L)	Choose one from a pool of courses, DSE 1 A/B/C (4) OR GE - 3 (4) (4 T/or 3T+1L/or 2T+2L) OR MOOC	AEC - 3 (2)	Choose one from SEC 3 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)	Choose one from a pool of courses VAC - 3 (2)	22
IV	DSC A(Botany) 4- (4) DSC B (Zoology) 4- (4) DSC C (Chemistry)4- (4) (3T+1L)	Choose one from a pool of courses, DSE 2 A/B/C (4) credits) OR GE - 4 (4) (4 T/or 3T+1L/or 2T+2L) OR MOOC	AEC - 4 (2)	Choose one from SEC 4 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)	Choose one from a pool of courses VAC - 4 (2)	22
Students on exit shall be awarded Undergraduate Diploma (in the field of Multidisciplinary study/Discipline) after securing requisite 88 credits in semester III & IV and vocational course of 4 credits (as per guidelines)						Total = 88
V	DSC A 1 (Botany) (4) DSC A 2 (Botany) (4) DSC B 1 (Zoology) (4) DSC B 2 (Zoology) (4) OR DSC B 1 (Zoology) (4) DSC B 2 (Zoology) (4) DSC C 1 (Chemistry) (4) DSC C 2 (Chemistry)(4) OR DSC C 1 (Chemistry) (4) DSC C 2 (Chemistry) (4) DSC A 1 (Botany) (4) DSC A 2 (Botany) (4) (3T+1L)	Choose one from a pool of courses, DSE 3 (A/B/C (4 credits) (3T+1L/or 2T+2L) OR GE - 5 (4) OR MOOC		Choose one from SEC 5 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)		22
VI	Same combination taken in V semester DSC A 1 (Botany) (4) DSC A 2 (Botany) (4) DSC B 1 (Zoology) (4) DSC B 2 (Zoology) (4) OR DSC B 1 (Zoology) (4) DSC B 2 (Zoology) (4) DSC C 1 (Chemistry) (4) DSC C 2 (Chemistry)(4) OR DSC C 1 (Chemistry) (4) DSC C 2 (Chemistry) (4) DSC A 1 (Botany) (4) DSC A 2 (Botany) (4)	Choose one from a pool of courses, DSE 4 A/B/C (4 credits) (3T+1L/or 2T+2L) or GE - 6 (4) OR MOOC		Choose one from SEC 6 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)		22

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	(3T+1L)					
Students on exit shall be awarded Bachelor of (in the field of Multidisciplinary study/Discipline) after securing requisite 132 credits on completion of semester VI						Total = 132
VII	DSC A/B/C 7 - (4) (3T+1L)	Choose 3 DSE (3x4) courses OR Choose 2 DSE – (2x4) and one GE (4) course OR Choose 1 DSE (4) and 2 GE (2x4) courses (Total= 12)		Dissertation on Major/Minor (4+2)		22
VIII	DSC A/B/C 8 - (4) (3T+1L)	Choose 3 DSE (3x4) courses OR Choose 2 DSE – (2x4) and one GE (4) course OR Choose 1 DSE (4) and 2 GE (2x4) courses (Total= 12)		Dissertation on Major/Minor (4+2)		22
Students on exit shall be awarded Bachelor of (in the field of Multidisciplinary study/Discipline) (Honours with Research) after securing requisite 176 credits on completion of semester VIII in Major (Discipline 1) and Minor (Discipline 2) as per guidelines						Total = 176








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Course Introduction:

The new curriculum of B.Sc. in Life Sciences with Botany, Zoology, and Chemistry as core disciplines offers a one-year Undergraduate certificate, two-year Undergraduate diploma three-year Undergraduate degree, and four-year Undergraduate degree (Hons. with Research) after securing the required credits as per the Curriculum and credit framework for Undergraduate program guidelines by UGC.

B.Sc. Life Sciences (Discipline specific core A - Botany) offers the 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 skill papers with significant interdisciplinary components. Students would be exposed to cutting-edge technologies currently being used in studying plant life forms, their evolution, and interactions with other organisms within the ecosystem. Students would also become aware of plants' social and environmental significance and relevance to the national economy.

B.Sc. Life Sciences (Discipline specific core A - Botany) covers academic activities within the classroom sessions along with practical concepts in laboratory sessions. Outstation activities and projects would also be organized for real-life experience and learning. Candidates who have curiosity in plants kingdom, and ecosystems, love exploring exotic places, and wish to work as researchers or professionals like botanists, conservationists, Ecologists, etc. can choose B.Sc. Life Sciences Course.

Eligibility for admission: Any candidate who has passed the Plus Two of the Higher Secondary Board of Examinations in any state recognized as equivalent to the Plus Two of the Higher Secondary Board in with PCB not less than 45%-marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per University rules

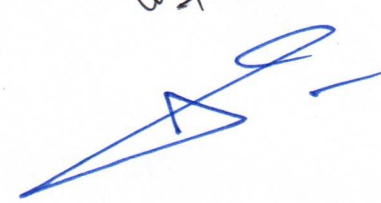
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Program Outcomes (POs):

A transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery learning, equipped with practice & skills to deal with practical problems, and versed with recent pedagogical trends in education including e-learning, flipped class, and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

PO-1	B.Sc. in Life Science offers theoretical as well as practical knowledge about different subject areas.
PO-2	Graduates will develop a scientific temperament to solve scientific problems in emerging areas of science at National and International levels.
PO-3	Graduates will acquire a coherent understanding of the academic field to pursue multi and interdisciplinary science careers in the future.
PO-4	Graduates will have clarity of thought and expression. Qualities like logical thinking and decision-making will be enhanced
PO-5	Graduates plan and execute experiments or investigations, analyze and interpret data information collected using appropriate methods
PO-6	Graduates will be able to compete in various national and international competitive examinations.
PO-7	Graduates will understand the principles of basic and applied sciences and apply them logically in environmental and socio-technological contexts with a systematic approach toward sustainable development.
PO-8	Graduates will have critical thinking, follow innovations and developments in Science and technology
PO-9	Graduates will acquire effective communication skills
PO-10	Graduates will understand ethical principles and responsibilities for effective citizenship.
PO-11	Graduates will develop new and enhancing conversational skills that lead not only to good communication but also to excellent drafting abilities linked with technical reports and presentations.
PO-12	Graduates will be competent enough for doing jobs in Govt. and private sectors of academia, research, and industry.



6 | Page

COURSE STRUCTURE

Semester Wise Discipline Specific Core

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	DSC-A (Botany)	BOTDC101	Microbes, Algae, Fungi, and Bryophytes	3	0	0	3
		BOTDL102	Practical/Lab Course	0	0	2	1
II		BOTDC201	Pteridophytes, Gymnosperms, and Angiosperms	3	0	0	3
III		BOTDL202	Practical/Lab course	0	0	2	1
		BOTDC301	Morphology and Anatomy	3	0	0	3
IV		BOTDL302	Practical/Lab course	0	0	2	1
		BOTDC401	Embryology and Cytogenetics	3	0	0	3
V		BOTDL402	Practical/Lab course	0	0	2	1
		BOTDC501	Economic Botany and Plant Breeding	3	0	0	3
VI		BOTDL502	Practical/Lab course	0	0	2	1
		BOTDC503	Seed Pathology	3	0	0	3
		BOTDL504	Practical/Lab Course	0	0	2	1
		BOTDC601	Physiology and Biochemistry	3	0	0	3
		BOTDL602	Practical/Lab course	0	0	2	1
		BOTDC603	Environment Microbiology	3	0	0	3
VII		BOTDL604	Practical/Lab Course	0	0	2	1
		BOTDC701	Mycology	3	0	0	3
VIII		BOTDL702	Practical/Lab Course	0	0	2	1
	BOTDC801	Palynology and Pollination Biology	3	0	0	3	
	BOTDL802	Practical/Lab Course	0	0	2	1	

Semester Wise Discipline-Specific Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
III	DSE-A (Botany)	BOTDE303	Analytical Techniques in Plant Sciences	3	0	0	3
IV		BOTDL304	Practical/Lab Course	0	0	2	1
		BOTDE403	Introduction to Medicinal and Aromatic plants	3	0	0	3
V		BOTDL404	Practical/Lab Course	0	0	2	1
		BOTDE505	Cell and Molecular Biology & Plant Biotechnology	3	0	0	3
VI		BOTDL506	Practical/Lab course	0	0	2	1
		BOTDE605	Ecology and Biostatistics	3	0	0	3

	BOTDL606	Practical/Lab course	0	0	2	1
VII	BOTDE703	Plant Resource Utilization and Conservation	3	0	0	3
	BOTDL704	Practical/Lab course	0	0	2	1
	BOTDE705	Microbiology	3	0	0	3
	BOTDL706	Practical/Lab course	0	0	2	1
	BOTDE707	Taxonomy and Diversity of Flowering Plants	3	0	0	3
	BOTDL708	Practical/Lab course	0	0	2	1
	BOTDE709	Research Methodology	3	0	0	3
	BOTDL710	Practical/Lab course	0	0	2	1
VIII	BOTDE803	Plant Health Management	3	0	0	3
	BOTDL804	Practical/Lab course	0	0	2	1
	BOTDE805	Genetics, Plant Breeding and IPR	3	0	0	3
	BOTDL806	Practical/Lab course	0	0	2	1
	BOTDE807	Freshwater algal flora of Himalaya	3	0	0	3
	BOTDL808	Practical/Lab course	0	0	2	1
	BOTDE809	Research Publication and ethics	3	0	0	3
	BOTDL810	Practical/Lab course	0	0	2	1

Semester Wise Generic Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	GE-A (Botany)	BOTGE103	Plant Science-I	4	0	0	4
II		BOTGE203	Plant Science-II	4	0	0	4
III		BOTGE305	Plant Science-III	4	0	0	4
IV		BOTGE405	Plant Science-IV	4	0	0	4
V		BOTGE505	Medicinal Plant Diversity of Uttarakhand	4	0	0	4
VI		BOTGE605	Global Climate Change	4	0	0	4

Semester Wise Ability Enhancement Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	AEC	AEC-104	Environment Science-I	2	0	0	2
II		AEC-204	Environment Science-II	2	0	0	2
III		AEC-304	English Communication-I	2	0	0	2
IV		AEC-404	English Communication-II	2	0	0	2

Semester Wise Skill Enhancement Course/IAPC

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	SEC-A/IAPCA (Botany)	BOTSC105	Nursery and Gardening	2	0	0	2
II		BOTSC205	Conservation and Management of Biodiversity	2	0	0	2

III		BOTSC306	Biofertilizers OR Internship/Apprenticeship / Project/ Community Outreach/MOOC.	2	0	0	2
IV		BOTSC406	Ethnobotany OR Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC.	2	0	0	2
V		BOTSC506	Mushroom Cultivation OR Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC	2	0	0	2
VI		BOTSC606	Herbal Technology OR Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC	2	0	0	2

Semester Wise Dissertation

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	BOTDT709	Dissertation on Major Core/Minor Elective (from VII Semester papers) OR Academic Project/ Entrepreneurship				6
VIII	IAPC	BOTDT809	Dissertation on Major Core/Minor Elective (from VIII Semester papers) OR Academic Project/ Entrepreneurship				6

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Discipline Specific Core

Semester-I

Microbes, Algae, Fungi, and Bryophytes

BOTDC101

Course Outcome

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

1. Remember: Define, Recall, select, and recognize the diversity of different microbes including viruses, Algae, Fungi, bryophytes & Lichens & their economic importance.
2. Understanding: Develop, describe, classify, and discuss understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance, and the structure and reproduction of certain selected bacteria, algae, fungi, bryophytes, and lichens
3. Apply: Explain the morphology, anatomy, and reproduction of Bryophytes. Thallus organization, classification, vegetative structure, and Life cycles of microbes, algae & fungi, and bryophytes.
4. Analyzing: Explain, differentiate, or classify conceptual skills about identifying microbes, pathogens, Biofertilizers & lichens.
5. Evaluating: Summarize, distinguish, or conclude knowledge about developing commercial enterprise of microbial products. Host-pathogen relationship and disease management.
6. Creating: Construct, develop, generalize, prepare, and write about the uses of microbes, fungi, algae, and lichens in various fields.

Unit	Topic	No. of lectures/ hrs (45)
1	Microbes : Viruses-discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); economic importance; bacteria-discovery, general characteristics, and cell structure; reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction); economic importance.	10
2	Algae: General characteristics; Range of Thallus organization and reproduction; classification of algae; morphology and life-cycles of Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Sargassum; economic importance of algae.	10

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3	<p>Fungi :</p> <p>Introduction-general characteristics, ecology, and significance, range of somatic thallus organization, cell wall composition, nutrition, reproduction and classification (G.C. Ainsworth); the life cycle of Stemonitis (Myxomycota) Rhizopus (Zygomycota) Penicillium (Ascomycota), Puccinia, Agaricus (Basidiomycota); Alternaria (Deutromycota), Symbiotic associations: Lichens-General account, reproduction, and significance; Mycorrhiza: ectomycorrhiza, endomycorrhiza and their significance.</p>	15
4	<p>Bryophytes:</p> <p>General characteristics, adaptations to land habit, classification (up to family), morphology, anatomy, and reproduction of Riccia, Marchantia, and Funaria; ecology and economic importance of bryophytes.</p>	10

Suggested reading

- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
- Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi, India.
- Pandey, S.N and Trivedi, P.S. (2015). A text book of Botany Vol.I Vikas publishing House Pvt/ Ltd, New Delhi.
- Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Bryophyta, S. Chand. Delhi, India.
- Parihar, N.S. (1991). An Introduction to Embryophyta Vol. I Bryophyta. Central Book Depot, Allahabad.

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Practical/Lab Course
BOTDL102

Course Outcomes:

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

1. To remember the instruments, techniques, lab etiquettes, and good lab practices for working in a microbiology laboratory.
2. Understand morphology, anatomy, reproduction, and developmental changes therein through typological study and create a knowledge base in understanding diversity, economic values & taxonomy of bryophytes.
3. Apply practical skills in the field and laboratory experiments in Microbiology and Pathology.
4. Analyze skills for identifying microbes and using them for Industrial, Agriculture, and Environment purposes.
5. Evaluate to identify algae, lichens, and plant pathogens along with their symbiotic and parasitic associations.
6. Students would learn to create their small digital reports where they can capture the zoomed-in and zoomed-out pictures as well as videos in case they are able to find some rare structure or phenomenon related to Bryophytes.

Unit	Topic	No. of Lectures/ hrs (60)
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	15
2	Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus, and Sargassum through temporary preparations and permanent slides/specimens	15

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Practical/Lab Course
BOTDL202

Course Outcomes:

1. Remember to aware of the group of plants that have given rise to land habit and the flowering plants.
2. Understand morphology, reproduction, and developmental changes therein through typological study
3. Apply through field study they will be able to see these plants growing in nature and become familiar with the biodiversity.
4. Analyze by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
5. Evaluate a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants.
6. Create: To discover and use diverse taxonomic resources, reference materials, herbarium collections,

Unit	Topic	No. of Lectures/ hrs (60)
1	Selaginella: Morphology, whole mount leaf with a ligule, strobilus, microsporophyll, and megasporophyll (temporary slides), T.S. stem, L.S. strobilus (permanent slide). Equisetum: Morphology, T.S. internode, L.S. strobilus, T.S and L.S. strobilus, whole mount sporangiophore, spores (wet and dry) (temporary slides); T.S. rhizome (permanent slide). Pteris: Morphology, T.S rachis, V.S. sporophyll, whole mount Sporangium and spores (temporary slides), T.S. rhizome, whole mount prothallus with sex organs and young sporophyte (permanent slide).	15
2	Cycas: Morphology (coralloid roots, bulbil, leaf), T.S. coralloid root and rachis, V.S. leaflet and microsporophyll, whole mount spores (temporary slides), L.S. ovule, T.S. root (permanent slide). Pinus: Morphology (long and dwarf shoots, male and female cones), T.S. needle and stem, L.S. /T.S. male cone, whole mount microsporophyll and microspores (temporary slides), L.S. female cone, TLS, and RLS stem (permanent slide).	15

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3	Taxonomic Identification: Description of a plant, the study of vegetative and floral characters (description, V.S. flower, a section of ovary, floral diagram/s, floral formula/e) and systematic position of the Following families according to Bentham and Hooker's system of classification: Brassicaceae, Asteraceae, Solanaceae, Lamiaceae, and Liliaceae. (Plants can be chosen as per the availability of local flora)	15
4	Herbarium techniques: Plant collection, preservation, and mounting of two properly dried and pressed specimens of any wild plant with herbarium label (to be submitted in the record book), digital/virtual herbarium.	15

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.
- Santra S.C. and Chatterjee (2005). College Botany Practical Vol. II New Central Book Agency Pvt. Ltd.

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Semester-III
Morphology and Anatomy
BOTDC301

Course Outcomes:

1. Remember the terms associated with the morphology and anatomy of plants.
2. Understand the morphology and anatomy of plants and the role of tissues in plant functions.
3. Apply to explain and write about Vascular cambium – structure and function, seasonal activity. Secondary growth, Epidermis, cuticle, stomata.
4. Analyze the vegetative characteristics of the plant, various tissue systems; the normal and anomalous secondary growth in plants, and their causes.
5. Evaluate the composition, modifications, internal structure & architecture of plants.
6. Create a digital herbarium and prepare the flora of locally available plants

Unit	Topic	No. of Lectures/ hrs (45)
1	Meristematic and permanent tissues: Types of tissues, Root and shoot apical meristems, Theories related to apical meristem, simple, complex and secretory tissues	10
2	Organs: Structure of dicot and monocot root, stem and leaf, root stem Transition	10
3	Adaptive and protective systems: Epidermis, cuticle, and stomata	5
4	Secondary growth: Structure and function of Vascular cambium, secondary growth in stem and roots, abnormal secondary growth	10

Suggested readings

- Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
- Pandey, B.P. (2001) Plant Anatomy. S. Chand and Company Ltd., New Delhi.
- Sharma, P.C. (2017). Text Book of Plant Anatomy. Arjun Publishing House.
- Menan, A.B. (2008). Introduction to Plant Anatomy. Neha Publishers and Distributors.
- Sharma, M.K. (2013) Plant Structures (An Introduction to Plant Anatomy). Vayu Education of India.

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BOTDL302

Course outcomes:

1. Remember the terms associated with the morphology and anatomy of plants.
2. Understand cell structure in monocot and dicot plants.
3. Apply to explain and write about Vascular cambium – structure and function, seasonal activity. Secondary growth, Epidermis, cuticle, stomata.
4. Analyze cell structure, secondary growth, and adaptive anatomy in plants.
5. Evaluate the composition, modifications, internal structure & architecture of plants.
6. Create a digital herbarium and prepare the flora of locally available plants

Unit	Topic	No. of Lectures (60 hrs)
1	Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma), complex and secretory tissues	15
2	Anatomy of monocot and dicot Stem; monocot and dicot leaf; monocot and dicot root (Plants can be chosen as per availability of local flora)	15
3	Adaptive anatomy: Xerophytes, Hydrophytes, Epiphytes (Plants can be chosen as per availability of local flora)	15
4	Normal and abnormal secondary growth in different plants (Plants can be chosen as per availability of local flora)	15

Suggested readings

- 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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Semester-IV
Embryology and Cytogenetics
BOTDC401

Course Outcomes:

1. Remember the principles and details of using light and electron microscopes and the role of X-ray diffraction in studying the structures of cellular organelles and biomolecules and defining various types of cell organelles and their functions. Properties of hereditary, Sex-determination, and Sex-linked Inheritance Linkage and Crossing over.
2. Understand reproduction and developmental changes in plants. Structure and chemical composition of chromatin and concept of cell division.
3. Apply Mendel's principles; acquire knowledge on cytoplasmic inheritance and sex-linked inheritance. Mutations and Chromosomal Aberrations,
4. Analyze to distinguish the Endosperm types, structure, and functions; Dicot and monocot embryo; Embryo- endosperm relationship.
5. Evaluate to summarize and justify about Pollination mechanisms and adaptations; Double fertilization; Seed- structure appendages and dispersal mechanisms.
6. Create to develop, construct or write about the Apomixis and polyembryony with their practical applications.

Unit	Topic	No. of Lectures (45 hrs)
1	Pollination and fertilization: Pollination mechanisms and adaptation, the structure of anther and pollen, development of male and female gametophytes, double fertilization.	10
2	Embryo and endosperm: Types of ovules and embryo sacs; embryo and endosperm; types of endosperm; dicot and monocot embryo; Apomixis and polyembryony.	10
3	Heredity: (Pre-Mendelian genetics, brief life history of Mendel, laws of Inheritance, modified Mendelian ratios, lethal genes, co-dominance, incomplete dominance, chi-square, pedigree analysis, multiple allelism, chromosome theory of inheritance, sex-determination and sex-linked inheritance, cytoplasmic inheritance Linkage and crossing over Linkage: concept and history, complete and incomplete linkage, bridges experiment, coupling and repulsion, recombination frequency, linkage maps based on two and three-factor Crosses.	15

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4	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
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Suggested readings

- 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
- Maheshwari, P. (1971). An Introduction to Embryology of Angiosperms. McGraw Hill Book Co. London.
- Rastogi, V.B. (2019). Genetics. 4th Edition. MEDTECH: A Division of Scientific International.

22 | Page



Practical/Lab Course
BOTDL402

Course Outcomes:

1. Remember the principles and details of using light and electron microscopes and the role of X-ray diffraction in studying the structures of cellular organelles and biomolecules.
2. Understand to study the structure of ovules and female gametophytes pollination and seed dispersal mechanism.
3. Apply Mendel's principles; and understand the monohybrid and dihybrid crosses and chromosomal changes.
4. Analyze to explain the types of ovules and Female gametophyte, type of embryo sac development. Ultrastructure of mature egg apparatus cells.
5. Evaluate the problems of Incomplete dominance and gene interaction through seed ratios.
6. Create the idea of polyploidy conditions in plants.

Unit	Topic	No. of Lectures (60 hrs)
1	Pollination types and seed dispersal mechanisms (photographs and specimens)	15
2	Structure of anther (young and mature). Types of ovules: anatropous, orthotropous, circinotropous, amphitropous, campylotropous. Female gametophyte: Polygonum (monosporic) type of embryo sac development (permanent slides/photographs) Ultrastructure of mature egg apparatus cells through electron micrographs (permanent slides/photographs)	15
3	Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square. Monohybrid cross (dominance and incomplete dominance), Dihybrid cross and gene interactions Pedigree analysis for dominant and recessive autosomal and sexlinked traits. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).	15
4	Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs. Photographs/permanent slides showing translocation ring, laggards, and inversion bridge	15

Suggested Reading

- Sundara, R.S. (2002). Practical Manual Anatomy and Embryology. Anmol Publisher, New Delhi.
- Singh, R.J. (2021). Practical Manual on Plant Cytogenetics. CRC Press, Taylor and

23 | Page

Semester-V
Economic Botany and Plant Breeding
BOTDC501

Course Outcomes:

1. Remember the role of plants in human welfare. Students will be able to gain the knowledge of Origin of Cultivated Plants, Plant Breeding, Methods of crop improvement, Inbreeding depression, and heterosis.
2. Understand the economic uses of various plants and the important objectives of plant breeding.
3. Apply methods of crop improvement.
4. Analyze the economically useful plants.
5. Summarize the procedure, advantages, and limitations of various crop improvement methods used for self-pollinated, cross-pollinated vegetatively propagated crops.
6. Develop the knowledge of plant parts used in medical form, beverage form, Fodder, Forage form, etc

Unit	Topic	No. of Lectures (45 hrs)
1	Origin of cultivated plants (concept of centers of origin, their importance with reference to Vavilov's work)	5
2	A brief knowledge of botany and commercial utilization and uses of the following plants: 1. Cereals and millets- Wheat, Rice and Maize, Ragi, Pearl millet 2. Sugar yielding plants- Sugarcane and Sugar beet 3. Fruits- Mango, Apple, Banana, Citrus and Litchi. 4. Fibers- Cotton, Jute, Hemp, Coir, Agave and Semal. 5. Vegetables- Root vegetables, stem vegetables and fruit vegetables. 6. Timbers- Teak, Shisham, Sal, Chir and Deodar. 7. Medicinal plants- Aconitum, Atropa, Cinchona, Rauwolfia, Ephedra, Withania, and Alo vera. 8. Oils, Beverages, Fumitories, masticatories, Spices and Condiments yielding plants.	15
3	Plant breeding (introduction and objectives; breeding systems, important achievements and undesirable consequences of plant breeding); methods of crop improvement; centres of origin and domestication of crop plants, plant genetic resources; acclimatization; selection methods.	10

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4	Hybridization: for self, cross and vegetatively propagated plants – procedure, advantages and limitations; inbreeding depression and heterosis (history, genetic basis of inbreeding depression and heterosis; applications); crop improvement and breeding (role of mutations; polyploidy; distant hybridization and role of biotechnology in crop improvement).	15
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Suggested readings

- Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.
- Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
- Acquaah, G. (2007). Principles of Plant Genetics and Breeding. Blackwell Publishing

Practical/Lab Course BOTDL502

Course Outcomes:

1. Remember the terms associated with economic botany and plant breeding
2. Understand the details of economic plants.
3. Apply the different techniques for breeding programs.
4. Analyze the chemistry of plants and herbal preparations.
5. Evaluate the diversity of economically important plants.
6. Create a Germplasm conservation strategy for future use.

Unit	Topic	No. of Lectures (60 hrs)
1.	Study of economically important plants: Cereals: Wheat, Rice, Maize; Millets: Finger millet, Foxtail, Ragi; Pulses: Gram, Green gram, Pea, Pigeon pea, Soyabean, Chickpeaa; Timbers: Shisam, Sal, Teak, Deodar, Pine	15
2.	Medicinal plants: Dhatura, Berginia, Hedychium, Poppy, Basil, Barberry; Beverages: Tea, Coffee; Oils: Mustard, Sesame, Coconut, Linseed, Groundnut, Castor, Laung, Sandalwood, mentha; Spices: Coriander, Cardamum, Curcuma, Cinamom, Laung, Cumin, Thyme, Nigella, Cinnamom leaf	15
3	Fibers: Jute, Coconut, Hemp, Urtica, Cotton; Sugars and starch yielding plants: Sugarcane, Potato, Beetroot Fruits and vegetables cultivated in the area. Gums and Resins.	15

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4	Hybridization techniques – Emasculation, Bagging (For demonstration only). Induction of polyploidy in plants (For demonstration only).	15
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Suggested readings

- Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.
- Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
- Acquaah, G. (2007). Principles of Plant Genetics and Breeding. Blackwell Publishing.

Seed Pathology BOTDC503

Course Outcomes:

1. Remember: Students are able to remember the term associated with seed pathology, history, concept and importance.
2. Understand: Understand and explain the importance of seed health and various types of seed-borne pathogens, various ways of transmitting disease through seeds in other ways and the importance of transmitting diseases through seeds.
3. Applying: Explain about the penetration of pathogens into seeds: Various kinds of pathogens enter into the seeds, the ability to live longevity of seed-borne pathogens: Factors that cause pathogens to be able to live long in seeds.
4. Analyzing: Analyze the spread of seed-borne pathogens: Spread of disease (monocyclic, polycyclic), survival of pathogens outside of seeds, how to control seed-borne diseases.
5. Evaluating: Evaluate to detect pathogens carried by seeds and seed health.
6. Creating: Comprehend and explain comprehensively about pathogens carried by fungi and bacteria in the form of works

Unit	Topic	No. of Lectures (Hrs)
1	Introduction, terminology and historical development, seed health and its importance.	3
2	Kinds of seed borne pathogens: fungi, bacteria, viruses, viroides and nematodes.	3
3	Types of damage caused by the seed borne fungi to seeds and crops.	2
4	Nature of seed infection. Systemic infection through flower, fruit and seed stock. Penetration through seed coat, natural openings and inflicted	6

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	openings.	
5	Longevity of seed borne pathogens. Factors influencing longevity.	4
6	Epiphytology of seed borne diseases, monocyclic and polycyclic diseases	3
7	Detection of seed-borne pathogens, objectives of seed health testing. Testing methods for seed borne fungi, seed borne bacteria, seed borne viruses and seed borne nematodes.	8
8	Study of seed borne diseases of certain specific crops, cereals, millets, pulses, oil crops, fibre crops, and vegetable and timber crops	10
9	Control of seed borne pathogens: selection of seed production areas, crop management, seed treatment, certification, plant quarantine and disease resistance	6

Suggested Readings

1. Neegard P. 1977. Seed Pathology Vol I and II. MacMillan Press, London
2. Suryanarayan, D. 1978. Seed Pathology. Vikas Publ. House. Pvt. Ltd. New Delhi.
3. Jha, D.K. 1995. A Text Book of Seed Pathology. Vikas Publ. House. Pvt. Ltd. New Delhi.
4. Agarwal, V.K. 1978. Principles of Seed Pathology. In (ed.) James B.S. Sindair. CRC Press. II Edition.
5. Desai, B.B. Seed Handbook. CRC Press.
6. Singh, Gurnam, Seed Pathology. Pointer Publisher, Jaipur.
7. Sing, T. Seed Technology and Seed Pathology . Pointer Publisher, Jaipur.
8. Nene, Y.L. and Agarwal, V.K. 1978. Some seed borne diseases and their control. ICAR, New Delhi

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Practical/Lab Course
BOTDL504

Course Outcomes

1. Remember: Remember the techniques used for the detection of seed borne pathogens.
2. Understanding: Understand the process of PCR, ELISA and other techniques.
3. Applying: Apply the seed soaking and seed washing test for the isolation of seed borne fungi or bacteria.
4. Analysing: Analyse the reduction of fungi by chemical treatment.
5. Evaluating: Evaluate the detection of fungi and bacteria by agar plate technique.
6. Creating: Symptomology test for the detection of seed borne diseases.

Unit	Topic	No. of Lectures (60 Hrs)
1	Field inspection of seed crops and visual examination of seeds for infections.	5
2	Seed soaking method for the detection of certain seed borne pathogens (fungi)	12
3	Seed washing tests and incubation methods, Seedlings symptomatology tests.	10
4	Detection of fungi and bacteria by Agar Plate methods	8
5	Visit to Seed testing laboratories, Certifying agencies, NBPGR	6
6	Demonstration of ELISA, PCR	4

Suggested Reading

1. Singh, Gurnam, Seed Pathology. Pointer Publisher, Jaipur.
2. Nene, Y.L. and Agarwal, V.K. 1978. Some seed borne diseases and their control. ICAR, New Delhi.
3. Jha, D.K. 1995. A Text Book of Seed Pathology. Vikas Publ. House. Pvt. Ltd. New Delhi.

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Semester-VI
Plant Physiology and Biochemistry
BOTDC601

Course Outcomes:

1. Remember the concept of water potential, diffusion, osmosis and Imbibition, Energy flow, Biomolecules, photosynthesis, metabolism, nitrogen fixation, translocation, and Phytohormones.
2. Understand the plants and plant cells in relation to water, nutrition, photosynthetic pathways, and respiration.
3. Apply: Explain the structure, composition, and functional mechanisms of various biologically important molecules like carbohydrates, amino acids, proteins and lipids, photosynthesis, respiration
4. Analyze the knowledge about membrane transport and translocation of water and solutes.
5. Summarize the process of photosynthesis in higher plants with particular emphasis on light and dark reactions, C3 and C4 pathways, respiration in higher plants with particular emphasis on aerobic and anaerobic respiration, ATP synthesis, and nitrogen metabolism.
6. Create a general idea of plant physiology and biochemistry

Unit	Topic	No. of Lectures (45 hrs)
1	Plant-water relations: Importance of water, water potential and its components; 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	10
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).	15

3	Nitrogen metabolism: Biological nitrogen fixation; nitrate and ammonia assimilation. Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.	10
4	Biochemistry: General introduction to carbohydrates, lipids and proteins. Enzymes (structure and properties; mechanism of enzyme catalysis and enzyme inhibition, factors affecting enzyme action).	10

Suggested Readings

- Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition.
- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Practical/Lab Course BOTDL602

Course Outcomes:

1. Gain knowledge of the determination of the osmotic potential of plant cell sap. Effect of the permeability of the cytoplasmic membrane, water potential, osmosis, and photosynthesis.
2. Understand the effect of environmental factors on transpiration.
3. Apply the formula to calculate the stomatal index and frequency of the plant leaf.
4. Analyze the separation of chloroplast pigment and amino acids by chromatography.
5. Evaluate the rate of respiration by Respirometer
6. Develop to demonstrate suction due to transpiration

Unit	Topic	No. of Lectures (60 hrs)
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/Farm potometer. Demonstration of the effect of light intensity and bicarbonate concentration on O ₂ evolution in photosynthesis by Wilmotts Bublcr.	18
2	Determination of R.Q of different respiratory substrates by Ganong's respirometer; Demonstration of anaerobic respiration in germinating seeds. Demonstrate Suction due to transpiration	18

30 | Page

2	Test of carbohydrates, proteins, and fats.	12
4	Separation of amino acids and chloroplast pigment by paper chromatography	6
5	Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte	6

Suggested Readings

- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
- Swami. (2012). Practical Botany Vol III. Pragati Prakashan, Meerut

Environment Microbiology BOTDC603

1. Remember the knowledge of Fundamentals of Microbial Ecology, Air and Aquatic Microbiology, Microbial Interactions, Pollution and Impact of Microbes on Environment.
2. Understand the metabolic processes of microorganisms, principally bacteria, to industrial processes related to the environment.
3. Explain the Microbial Ecology.
4. Analyse design experiments and interpret results.
5. Summarized and use the properties of microorganisms, principally bacteria, to remedy problems of contamination and other environmental impacts.
6. Generalized the knowledge of Microbial Ecology.

Unit	Topic	Lecture (45 Hrs)
1	Fundamentals of Microbial Ecology Ecosystem; Biotic and abiotic components; Habitat and Niche; Population and guilds; Concept of community, Concept of ecological niche; Ecosystem organization: Structure and functions, Primary production, Energy dynamics (Trophic organization and energy flow pathways).	9
2	Air and Aquatic Microbiology: Droplet nuclei, Aerosol, Assessment of air quality, Solid and liquid impingement methods, Brief account of air born transmission of microbes; Aquatic microbiology: Zonation and microbiota of fresh water (Ponds, lake and rivers), Eutrophication, Microbial assessment of water quality, Water purification	9
3	Microbial Interactions, Positive and negative interactions amongst microbial populations: Cooperation, Neutralism, Commensalism, Synergism, Mutualism, Competition, Amensalism, Parasitism, Predation; Interactions between microorganisms and plants: Rhizobacteria, Mycorrhiza, Epiphytic and endophytic microorganisms, Cultivation of microorganisms by animals	9

	for food and food processing	
4	Air pollution and its control; Sources, Major pollutants, Adverse effect on living organisms (Acid rain and its impact on ecosystem, greenhouse effect, global warming, ozone layer depletion and its effect, smog), Control through; Water pollution and its control: Sources, Ground water contamination, Wastes: Characterization of solid and liquid wastes, Solid waste treatment (Landfills, incineration, composting, anaerobic digestion and pyrolysis), Waste water treatment	9
5	Impact of Microbes on Environment; Biodegradation of recalcitrant compounds: Pesticides and Petroleum; Bioremediation: In situ and Ex situ remediation	9

Suggested Readings

1. Alexander, M. Microbial ecology. John Wiley and Sons, New York.
2. Eldowney, S., and Waites, S. Pollution: Ecology and bio treatment. Longman, Harlow.
3. Marshal, K.C. Advances of microbial ecology. Plenum Press, New York.

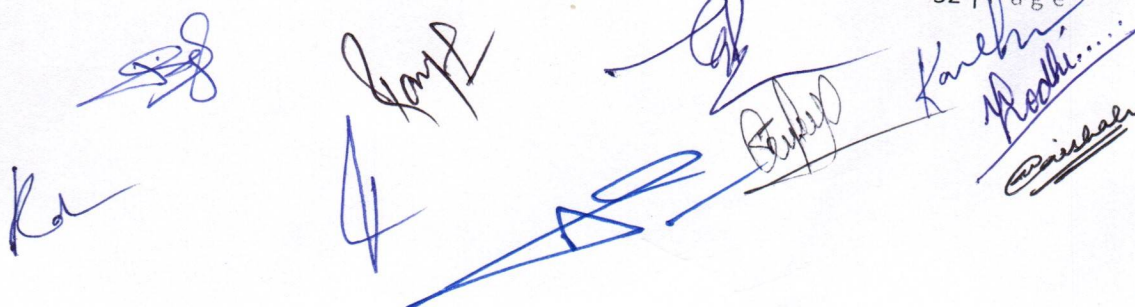
Practical/Lab Course

BOTDL604

Course Outcomes:

1. Remember sampling and enumeration techniques for microbes.
2. Understand working principle and technique of Autoclave, Centrifuge, LAF, PCR
3. Apply agar medium for culturing of microorganism of our surroundings.
4. Analyse total microbial count in a water sample
5. Evaluate fungi/bacteria by pour-plate, spread-plate and streak plate method.
6. Create differential medium for the growth of bacteria.

Unit	Topic	No. of Lectures (60Hrs)
1	Sampling and enumeration techniques for microbes.	
2	Determination of total microbial count in a water sample.	10
3	To prepare the Nutrient Agar/CDA/MEA medium for culturing bacteria and Fungi present in our surroundings.	7
4	Isolation of Fungi/bacteria by the Pour- plate method, Spread-plate and Streak Plate method.	10
5	To prepare the differential medium (MacConky) so as to grow the bacteria.	7
6	Isolation of fungi from the given sample of water and soil.	10
7	Working principle molecular technique-PCR, Autoclave, Centrifuge, LAF etc	6



Suggested Readings

1. Hurst, Crawford, Garland, Lipson, Mills & Stetzenbach. 2007. Manual of environmental microbiology. 3th Edition. ASM Press.
2. Husain Hadi Khan et al. 2019. Practical Lab manual for microbiology and plant pathology, Akinik Publication, Delhi.

Semester-VII

Mycology

BOTDC701

Course Outcomes:

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

1. Remember the knowledge about the history, concept and scope of mycology.
2. Understand the general characters, structure, nutrition, reproduction and the principles on classifications of Fungi.
3. Explain and think about the symptoms and causal organisms of various fungal diseases of plants.
4. Analyze the economic and pathological importance of fungi.
5. Summarized the occurrence, general characters, types, reproduction and life cycles of the major fungal groups.
6. Develop fungal associations and fungal physiology.

Unit	Topic	Total No. of lecturers/hrs (45)
1	General characteristics (Somatic structures, cell wall composition, and nutrition in fungi), Reproduction in Fungi (vegetative, asexual, and sexual), Heterothallism and Heterokaryosis, Parasexual cycle, Mycorrhiza.	10
2	Recent trends in classification of fungi, phylogeny of Fungi, Importance of Fungi.	5
3	A general account of the following classes of fungi with emphasis on the given genera: Myxomycotina: Stemonitis, Physarum Mastigomycotina: Allomyces, Monoblepharis. Oomycotina: Saprolegnia, Pythium, Phytophthora, Sclerospora. Zygomycotina: Mucor, Pilobolus, Entomophthora.	15

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Palynology and Pollination Biology
BOTDC801

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

1. Remember and Recall the general concepts of palynology.
2. Learn and understand the structure and development of pollen wall development.
3. Examine the morphological features of Spore-pollen.
4. Relate and identify the various aspects of Palynotaxonomy.
5. Analyze the importance of aero-palynology with reference to allergy.
6. Determine the concepts, scope and future perspectives of Melissopalynology

Unit	Topic	Total No. of lecturers/hrs (45)
1	General Introduction, microsporogenesis, microspore tetrads and polarity of spores and pollen grains. Pollen wall development and pollen chemistry, Chemical nature of sporopollenin, development of pollen wall, Ubisch body, pollen wall proteins, origin and formation exineless pollen grains.	10
2	Spore-pollen morphology: Symmetry, shape, size, aperture patterns, NPC System for numerical expression of apertural details, exine stratification, surface structures and sculptures of sporoderm. Palynotaxonomy: Systematic palynology, identification key and evolutionary trends among pollen grains based on palynotaxonomical works.	10
3	Aeropalynology with reference to allergy: Aeroallergens, introductory idea of Immune System with special reference to IgE. Study of airspora, chemical nature of exine-borne allergens, allergic taxa of North-West Himalaya. Melissopalynology: Indian species of honey bees, importance of pollen grains as constituent of bee-bread, pollen-collecting mechanism of honey bees, analysis of pollen load and honey sample in understanding bee forage, objectives of melissopalynological studies, and important bee plants of North-West Himalaya.	15
4	Forensic palynology: Definition and significance, a few well-known case studies. Pollination Biology: Pollen dispersal units; pollination types, contrivances for cross- and self- pollination; pollen vectors, pollination modes and flora organization, Pollen viability and storage.	10



Suggested Readings

1. Erdtman, G. 1952. Pollen morphology and Plant Taxonomy, Angiosperm: Almquist and Wiksell, Stockholm.
2. Bhattacharya, K. and Majumdar, M.R. 2011. A text book of Palynology. P364. New Central Book Agency.
3. Nair, P.K.K. 1966. Essentials of Palynology; Asia Publication House Lucknow.
4. Woodhouse, R.P. 1935. Pollen Grains: Hafner Publication Co.

Practical/Lab Course BOTDL802

Course Outcomes:

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

1. Examine the pollen grains from honey samples and to study the frequency of different Morphotypes.
2. Distinguish the in vivo and in vitro germination of pollen grains.
3. Apply knowledge to study allergy producing pollen Morpho-types
4. Analyze Morpho-anatomical study of stigma and style
5. Evaluate pollen viability of angiosperms
6. Solve the problem related pollen morphology

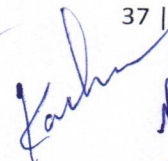
Unit	Topic	Total No. of lecturers/ hrs (60)
1	Pollen morphological studies of some Pteridophyte, gymnosperms, and angiosperms representing different morphological types using acetolysis / alkali maceration method.	20
2	Study of in vivo and in vitro germination of pollen grains.	15
3	Study of allergy producing pollen morpho-types.	5
4	Determination of pollen viability	5

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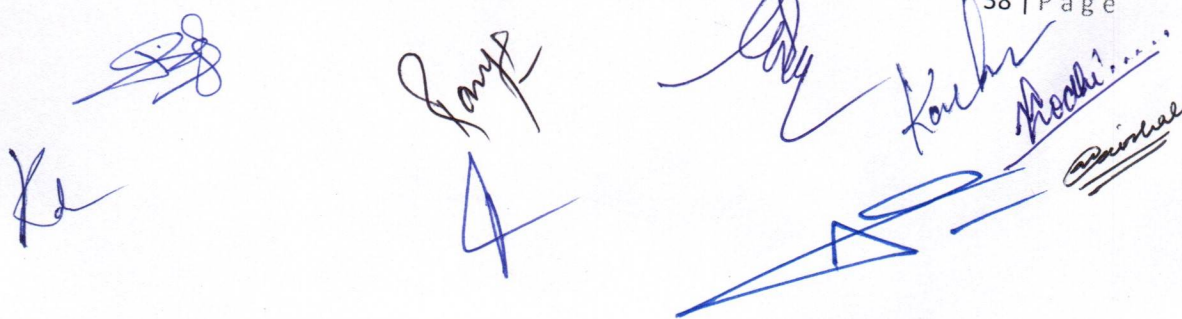
37 | Page


Discipline-Specific Elective
Semester-III
Analytical Techniques in Plant Sciences
BOTDE303

Course outcomes:

1. Remember the principles of different types of microscopy; types of centrifugation, spectrophotometry, chromatography; techniques of characterization of proteins and nucleic acids; preliminary biostatistics and terminology associated with it.
2. Understand and perform Chromatography and cultural techniques in Botany
3. Apply methods used in Micrometry, Microtomy and Microphotography.
4. Analyze paper chromatography for separation of chloroplast pigments, principles and technicality of Mass spectroscopy, X-ray diffraction, X-ray crystallography and various types of electrophoresis techniques.
5. Evaluate electrophoresis and Blotting techniques for DNA, RNA, and, protein characterization.
6. Create and execute the applications of paper chromatography, column chromatography, TLC, GLC, HPLC and Biostatistics in Plant Sciences.

Unit	Topic	Lecture (Hrs)
1	Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining	9
2	Cell fractionation Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl ₂ gradient, analytical centrifugation, ultracentrifugation	9
3	Spectrophotometry Principle and its application in biological research.	4
4	Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography, Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE	9
5	Biostatistics Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.	14



Suggested Readings

1. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A
2. S.D. Ramteke and J.H. Meshram. (2019). Plant Analytical Techniques, p236, Daya Publication House, New Delhi
3. P.K. Banerjee. (2012). Biostatistics. S. Chand Publ., New Delhi.

Practical/Lab Course Analytical Techniques in Plant Sciences BOTDL304

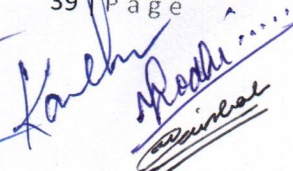
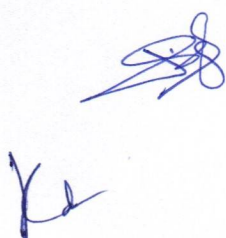
Course Outcomes:

1. Remember Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR
2. Understand different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH)
3. Apply paper and column chromatography to separate chloroplast pigment
4. Analyze protein separation and DNA using PAGE and AGE
5. Evaluate Rf factor for the separation of chloroplast pigments
6. Prepare permanent slides by using double staining.

Unit	Topic	Lecture (60Hrs)
1	Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs. Demonstration of ELISA.	8
2	Isolation of chloroplasts by differential centrifugation. To separate chloroplast pigments by column chromatography and paper chromatography	16
3	To estimate protein concentration To separate proteins using PAGE	16
4	To separate DNA using AGE	8
5	Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH). Preparation of permanent slides (double staining).	12

Suggested Readings

1. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
2. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3 rd edition.



Semester-IV
Introduction to Medicinal and Aromatic Plants
BOTDE403

Course Outcomes:

1. Remember the Knowledge of medicinal and aromatic plants, their importance, and status and future prospects.
2. Understand the medicinal plant diversity of India and the organisation associated with its promotion.
3. Apply Practice and conserve the medicinally important herbs
4. Analyse and Explain aromatic plants used in different industries particularly Perfume industry.
5. Evaluate and justify the role of agencies constituted for promotion of medicinal plant sector at national level.
6. Create or adapt the benefits of Medicinal and Aromatic Plants.

Unit	Topic	Lecture (60Hrs)
1	MAPs: definition, history, importance and future prospects. Medicinal Plants – past and present status in world and India. MAPs as industrial crops - constraints and remedial measures. Medicinal plant diversity & local healthcare. Medicinal plant conservation – issues and approaches. Medicinal plant conservation areas (MPCA), Non-timber forest products (NTFP); Indian Himalayan MAPs	12
2	Promotion of medicinal plant sector at national level: National Medicinal Plant Board and State Medicinal Plant Boards - objectives and functions.	6
3	Important medicinal plants of India with their systematics, geographical distribution and uses. Acorus calamus, Adhatoda vasica, Abrus precatorius Aloe vera, Phyllanthus amarus, Stevia rebaudiana, Belladonna and Cinchona	9
4	Important aromatic plants of India with their systematics, geographical distribution and uses. Introduction and historical background of aromatic plants. Aromatic and cosmetic products.	8
5	Raw material for perfumes etc. Cosmetic Industries. Major, minor and less known aromatic plants of India. Taxonomic descriptions and uses of important aromatic plants – citronella, damask rose, geranium, khus grass, large cardamom, lavender, lemon grass, mentha, holy basil, patchouli, rosemary, Palmarosa, vetiver, artemisia, eucalyptus, thyme, and oreganum. Aromatic spices - clove, cinnamon, nutmeg, ajwain, , tamarind, , curry leaf and saffron	10

Suggested Readings

1. Medicinal Plants of Uttarakhand by C.P. Kala (2010).
2. Indian Medicinal Plants by P.C. Trivedi (2009). Pointer Publ. Jaipur
3. Handbook of MAPs by S.K. Bhattacharjee (2009).

Practical/Lab Course
Introduction to Medicinal and Aromatic Plants
BOTDL404

Course Outcomes:

- Remembering: List the steps involved in steam distillation, various phytochemicals present in medicinal plants. Identify common bacterial/Fungal strains used in antimicrobial tests
- Understanding: principle of steam distillation and why it is used for extracting essential oils. Significance of different phytochemicals in medicinal plants. Factors affecting the growth of aromatic plants
- Applying: Implement cultivation practices for growing aromatic plants. Conduct the agar well diffusion method to test antimicrobial activity.
- Analysing: Analyze the results by measuring the zones of inhibition. Interpret the results of phytochemical tests.
- Evaluating: Assess the medicinal potential of the plant based on the phytochemical profile. Compare the antimicrobial efficacy of different plant extracts.
- Creating: Design an optimized cultivation plan for medicinal and aromatic plants

S.N	Experiment	Lecture (60 Hrs)
1	Extraction of Essential Oils from Lavender, Peppermint or locally available plants	12
2	Study of medicinal and aromatic plants of India with special reference to Uttarakhand (Botanical name, common name, and uses)	12
3	Phytochemical screening of medicinal plants viz., Neem, Tulsi	12
4	Antimicrobial activity of Medicinal plants	12
5	Study the growth and cultivation practices of medicinal and aromatic plants	12

Suggested Readings

Harborne, J.B. (1998). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*. Chapman & Hall.



Semester-V
Cell and Molecular Biology & Plant Biotechnology
BOTDE505

Course outcomes:

1. Remember the principles and details of using light and electron microscopes and the role of X-ray diffraction in studying the structures of cellular organelles and biomolecules and define various types of cell organelles and their functions. Basic tools of Plant tissue culture, Recombinant DNA Techniques.
2. Identify the role of enzymes in plant development and basic techniques of Biotechnology.
3. Explain the basic principles of microscopy and basic techniques of Recombinant DNA Technology
4. Analyze the process of cell cycle with reference to mitosis and meiosis.
5. Compare and Discuss about the SEM and TEM with reference to their applications in plant study. Basic concept of biotechnology and its application with reference to plants.
6. Construct the structures of different RNA and enzymes used in transcription

Unit	Topic	No. of Lectures (45 hrs)
1	Cell Biology: The cell theories, prokaryotic and eukaryotic cells, cell organelles (Mitochondria, Chloroplast, ER, Golgi body, lysosomes, peroxisomes, nucleus, chromatin; DNA packaging in eukaryotes, Euchromatin and heterochromatin, nucleolus and ribosome structure), cell membrane and cell wall; models of membrane structure, cell cycle (overview of cell cycle, mitosis and meiosis, molecular controls).	10
2	Molecular Biology: Genetic material (DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material); DNA replication (Prokaryotes); Transcription (Prokaryotes) Types of structures of RNA (mRNA, t RNA, r RNA); Translation (Prokaryotes), Regulation of gene expression (Prokaryotes: Lac operon and Tryptophan operon).	15
3	Plant tissue culture: Culture types on the basis of explants and media composition, General lab setup and instrumentation, micropropagation, A brief account of protoplast culture, and somatic embryogenesis with their applications.	10

42 | Page

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4	Recombinant DNA techniques: Blotting techniques: Northern, Southern, and Western Blotting, Molecular DNA markers i.e. RAPD, RFLP, SNPs, PCR, hybridoma and monoclonal antibodies, ELISA	10
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Suggested readings

- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G.P. (2009). The World of the Cell. 7th edition.
- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

43 | Page

Discipline-Specific Elective

Semester-V

Practical/Lab Course

BOTDL506

Course outcomes:

1. Examine various cell organelles through slides and photographs.
2. Gain an understanding of temporary mount and slides of mitosis and meiosis.
3. Practice the section cuttings.
4. Illustrate the structure of nuclear pore complex by photograph.
5. Measure the cell size (either length or breadth/diameter) by micrometry.
6. Test the process of plasmolysis and deplasmolysis on Rhoeo leaf and Assemble the knowledge of Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation

Unit	Topic	No. of Lectures (60 hrs)
1	Structure of prokaryotic cells (bacteria), viruses, and eukaryotic cells with the help of light and electron micrographs. Study of the photomicrographs of cell organelles, the structure of plant cell through temporary mounts. Study of mitosis and meiosis (temporary mounts and permanent slides). Demonstration of the effect of temperature, organic solvent on the semi-permeable membrane. Study of plasmolysis, deplasmolysis,	20
2	Instruments and equipment used in molecular biology The cell size measurements (either length or breadth/diameter) by micrometry. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene and lampbrush) either by slides or photographs. Study DNA packaging by micrographs. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.	20
3	Familiarization with basic equipment in tissue culture. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE	20

Suggested readings

- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc.
- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

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SEMESTER-VI
Ecology and Biostatistics
BOTDE605

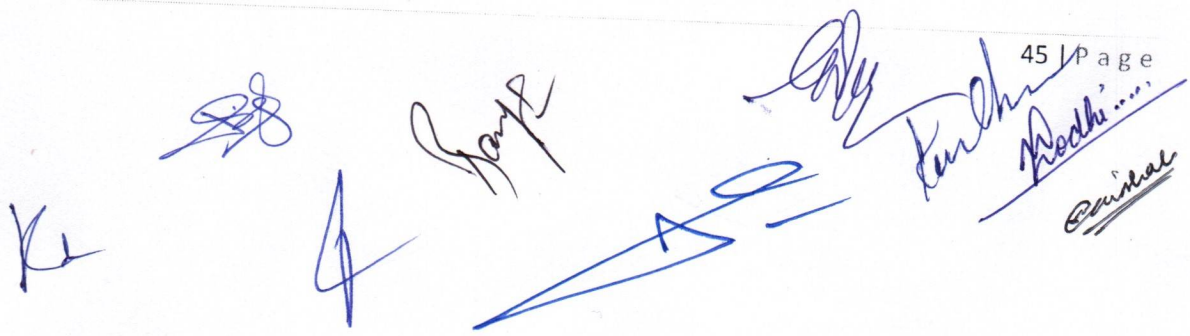
Course outcome

1. Remember to define various components of environment and ecosystem and biostatistical terminology.
2. Understand methods for studying vegetation, community patterns and processes, ecosystem function, and principles of phytogeography.
3. Applying: different statistics tools to solve problems in biology.
4. Analyze complex interrelationships between organisms and the environment.
5. Evaluate strategies for sustainable natural resource management and biodiversity conservation.
6. Create to develop, write or construct Biogeochemical cycling in nature

Unit	Topic	No. of Lectures (45 hrs)
1	Ecological factors: Soil (Origin, formation, composition, soil profile) Plant adaptation in relation to water (Hydrophytes and xerophytes), light (Sciophytes and heliophytes), and temperature; Pollution: Water, Soil and Radioactive.	10
2	Ecosystem: Types, structure, energy flow, trophic organization, food chains and food webs, ecological pyramids. Biogeochemical cycles: Cycling of carbon, nitrogen, and phosphorous. Population: Characteristics, Growth curves, Ecotypes, and Ecads Plant communities: Characteristics, plant succession, Biological spectrum Biodiversity conservation	15
3	Biostatistics: Definition and scope of statistics, sampling techniques, representation of data: tabular, graphical, etc Measures of central tendency: Arithmetic mean, mode, median.	10
4	Measures of dispersion: range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit Regression analysis	10

Suggested reading

- 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.
- Rastogi, V.B. (2015). Biostatistics. Medtech, 3rd Edition.
- Banerjee, P.K. (2006). Introduction to Biostatistics. S. Chand and Company Ltd., Ram Nagar, New Delhi.



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- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.

Practical/Lab Course BOTDL606

Course Outcomes:

1. Remember the knowledge of instruments used to measure microclimatic variables.
2. Understand effect of environmental factors on transpiration.
3. Apply practical knowledge of biostatistics implemented in the biodiversity assessment and conservation.
4. Analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
5. Evaluate morphological adaptations of hydrophytes and xerophytes and rate of respiration.
6. To test goodness of fit using chi-square.

Unit	Topic	No. of Lectures (60 hrs)
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, organic carbon, nitrogen and phosphorus. 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 (Cuscuta), root parasite (orobanche), epiphytes, predation (insectivorous plants) through specimen or diagrams. 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 study of dominant tree species of the locality.	30
4	Analysis of statistical data: mean, median and mode by analyzing the given data of individual, discrete and continuous series, standard error and deviation Numerical based on correlation coefficient Numerical based on chi square value. Representation of data by making graphs and diagrams etc. Comment upon given graphs, diagrams etc.	30

Suggested Readings

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

- Banerjee, P.K. (2016). A textbook of Biostatistics. S. Chand Publ., New Delhi.

SEMESTER-VII
Plant Resource Utilization and Conservation
BOTDE703

- Course outcomes:** After the completion of the course the students will be able to:
1. Remember and define the concepts of Plant resources its economic value and conservation
 2. Describe economically important plants with binomial names, family and uses.
 3. Explain the various uses of plants; biodiversity status, loss and management strategies
 4. Analyze initiatives for biodiversity conservation.
 5. Evaluate the economically important product and its utility,
 6. Create Germplasm storage for the conservation of economically important crops.

Unit	Topic	Total No. of lecturers/ hrs (45)
1	Sustainable development: Basic concepts. World centres of primary diversity of domesticated plants: The Indo-Burmese centre plant introduction and secondary centres. An idea of (i) Food, forage and fodder crops. (ii) Fibre crops. (iii) Medicinal and Aromatic Plants and (iv) Vegetable oil-yielding crops and their uses.	10
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).	15
3	Strategies for conservation- in-situ conservation: International efforts and Indian initiatives; protected areas in India- sanctuaries, National Parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation on wild biodiversity.	10

47 | Page

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4	Strategies for conservation-ex-situ conservation: Principles and practices; botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks, 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.	10
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Suggested readings

- 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.
- 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 Resources, (IBPGR), Rome, (Italy)
- Pullin A.S. (2002). Conservation Biology. Cambridge University, Press, London.
- Watson, R.T., Heywood, V.H., Baste, T., Dias, B., Gámez, R., Janetos, T., Reid, W. Ruark, G. (1995). Global biodiversity assessment: summary for policy- makers. Cambridge (England).

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**Practical/Lab Course
BOTDL704**

- Course outcomes:** After the completion of the course the students will be able to
1. Recall the knowledge of different plant resources and its utilization
 2. Understand Morphology, anatomy and uses of different crop plants
 3. Apply micro-chemical test for the detection of carbohydrate and proteins in crops.
 4. Analyze microscopic study of whole fibers using appropriate staining procedures.
 5. Evaluate Iodine Value
 6. Create strategies for conservation of biodiversity

Unit	Topic	Total No. of lecturers/hrs (60)
1	The practical course of this section is divided into three units 1) Laboratory work, (2) Field survey and (3) Scientific visits i. Food crops: wheat, rice, maize, chickpea, potato, tapioca, sweet potato, sugarcane; morphology, anatomy and micro-chemical tests for stored food materials.	15
2	ii. Forage/fodder plants: Study of ten important fodder crops of the locality.	5
3	iii. Plant fibers: Textiles fibers (cotton, jute, sun hemp, cannabis, Grewia, etc.), Cordage fibers (coir), Stuffing fibers (silk cotton). Morphology, anatomy, microscopic study of whole fibers using appropriate staining procedures. Medicinal and aromatic plants including antibiotics.	10
4	Vegetable oils: Mustard, groundnut, soybean, coconut, sunflower and castor. Morphology, microscopic structure of oil yielding tissues, test for oil, Iodine value	10
5	Scientific visits, Field trips, compilation of field notes, the preparation of herbarium sheets and submission of herbarium and museum specimens potted specimens of taxonomic interest and submission of the excursion report.	5

Suggested Readings

Bijan Bihari Dutta. (2015). A Handbook of Plant Resource Utilization and Conservation. Publ. by Authors press.

49 | Page

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Microbiology BOTDE705

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

1. Recall the knowledge about the history, concept and scope of Microbiology.
2. Understand the occurrence, general characters, types, reproduction and life cycles of the major microbial groups and their role in food, clinical and industrial microbiology.
3. Apply practical skills in basic microbiological techniques.
4. Analyze the importance of the characteristics, mode of reproduction and economic importance of Viruses and update the knowledge of basic of immunology.
5. Evaluate the classificatory approaches and advances in bacterial, viral and lichen taxonomies.
6. Generalized the knowledge about the Microbiology

Unit	Topic	Total No. of lecturers/hrs (45)
1	General account of Microorganisms: History of microbiology, Golden Era of Microbiology, characteristic features of bacteria, General account of actinomycetes, classification of microorganism-five kingdom classification, Microbial growth- measurement of microbial growth, Batch, Fed-batch and continuous culture, endophytic microorganisms.	12
2	Morphology and structure of Bacterial cells: Morphology of bacterial cells based on size, shape and arrangement, fine structure of bacterial cells (of both gram negative and gram positive bacteria) capsule cell wall, cell appendages (flagella, fimbriae, pilli), structure of plasma membrane, cytoplasmic inclusions-mesosomes, chlorosome. Ribosome- Site of protein synthesis, microbial genetics- transformation, conjugation and transduction.	13
3	Morphology and structure of viruses: History, morphology, fine structure, shape and classification of viruses. Mycophages and Prions, Tobacco mosaic virus (TMV), T4 Bacteriophage and HIV- their fine structure, genome organization and multiplication, bacteriophage therapy, Corona virus.	12
4	General account of lichens: Occurrence and distribution, trends in classification, morphological diversity, type forms and ecological groups anatomy (homeomerous and heteromerous), reproduction, economic importance of lichens, lichenic acid.	8

50 | Page

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Suggested Readings:

- Alexander, M. (1991). Microbial Ecology. John Wiley and Sons. New York.
- Doelle, H.W. and C.G, Heden (1986). Applied Microbiology, Kulwer Academic Press, London.
- Kathleen Park, Talaro and Barry Chess. (2017). Foundations in Microbiology. Mc Graw Hill New York, 10th edition.
- Kaushik, P. (1996). Introductory Microbiology. EmkayPubl, Delhi.
- Madigan, Bender, Buckley, Sattley, Stahl. (2019). Brock Biology of Microorganisms. Pearson. 15th edition.
- Marjorie, Kelly. And Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw 42ioferti York, 5th edition.
- Miller, B.M. and W. Litsky (1976). Industrial Microbiology. Mc Graw Hill New York.
- Norris, J.R. and Ribbons D.W. (1970). Methods in Microbiology. Academic Press, London.
- Pelczar, M.J., Chan, ECS and Kreig, N.R. (1993). Microbiology. McGraw Hill, New York. Fifth Edition.
- Power, C.B. and Daginawala H.F. (1996). General Microbiology. Vol 2. Himalaya Pub. House, New Delhi.
- Tortora, G. J., Funke, B.R. and Case C.L.(2021). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 13th edition.
- Willey, Joanne, Sherwood, Linda., Woolverton, Christopher J.(2017). Prescott's Microbiology. McGraw Hill New York, 11th edition.

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Practical/Lab Course
BOTDL706

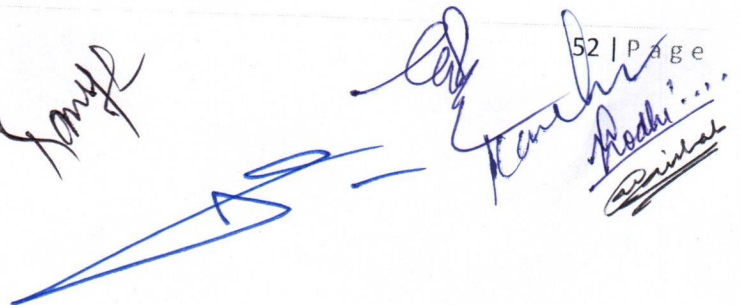
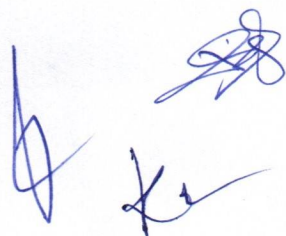
Course Outcome:

1. Recall the knowledge of different groups of microbes.
2. Understanding about different instruments and lab safety rules
3. Illustrate the methods of isolation and identification
4. Analyze the agar plate technique for isolation, enumeration and identification of microbes
5. Reframe the identification and Isolation of bacteria
6. Assemble the knowledge of media preparation

Unit	Topic	Total No. of lecturers/hrs (60)
1	Aseptic methods and demonstration of instruments viz., autoclave, hot air oven, incubator, laminar-airflow.	15
2	Isolation and enumeration of microbes from natural samples (soil and water) by agar plate technique	15
3	Direct examination of root nodule bacteria under microscope and isolation of Rhizobium in root nodules	15
4	Symptomology and diseased specimens of plants caused by bacteria and viruses	15

Suggested Readings

- B.P. Pandey. (2019). Practical Botany-Revised ed. S. Chand Co. Ltd. Delhi
- Aneja, K.R. 2016. Experiments in Microbiology, Plant Pathology, Tissue Culture and Biotechnology, New Age International Publisher.



Taxonomy and Diversity of Flowering Plants BOTDE707

Course Outcome:

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

1. Remembering the depth knowledge salient features of angiosperms, concept of origin and evolution of angiosperms.
2. Understand about the diversity, description, identification, nomenclature and classification of plants
3. Familiarized with the salient features of ICBN/ICN species concept, taxonomic hierarchy, and delimitation of taxa and attribution of rank.
4. Analyze the types of inflorescence and their origin. Analyze the plants and describe them taxonomically
5. Summarized the concepts of phytogeography, endemism, plant migration, invasions and introduction. Skills in Plant inventory and exploration, identification and its conservation.
6. Develop the characteristic features and economic importance of some important families.

Unit	Topic	Total No. of lecturers/hrs (45)
1	Important system of classification Bentham & Hooker, J. Hutchinson and Angiosperm Phylogeny Group (APG IV) classification and their merits and demerits, Salient Features of International Code of Botanical Nomenclature (ICN) Elementary idea of molecular taxonomy. The species concept: Taxonomic Hierarchy, species, genus, family and other categories. Principles used in assessing relationships, delimitation of taxa and attribution of rank.	10
2	Origin of intra-population variation. Population and the environment, ecads, ecotypes, evolution and differentiation of species. Plant exploration in India with special reference to Uttarakhand. Origin and evolution of angiosperms, fossils, Type of inflorescence and their origin.	10
3	Taxonomic tools, herbarium, flora, histological, cytological, phytochemical, serological, biochemical, and molecular techniques. Concepts of phytogeography, endemism, plant migration, invasions and introduction.	10

53 | Page

4	Distinguishing features of the following families and their economic importance: Ranunculaceae, Violaceae, Rutaceae, Fabaceae, Rosaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Poaceae.	15
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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.
- Bensen, L. (1957). Plant Classification. Reprint Oxford & IBH. N. Delhi.
- Gaur, R.D. (1999). Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.
- 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.

Practical/Lab Course BOTDL708

Course Outcome:

1. Recall the knowledge of different genera belong to different classes of Angiosperms
2. Understand the basic terminology of taxonomy
3. Apply the methods of identification with the help of keys and flora
4. Execute and analyze the herbarium preparation and to enhance their knowledge regarding conservation of plants through field trips
5. Justify the knowledge of locally available flora
6. Report preparation of Field trips, compilation of field notes, the preparation of museum specimens and/or live potted specimens of taxonomic interest and submission of the excursion report

Unit	Topic	Total No. of lecturers/hrs (60)
1	Identification and description of locally available plants belonging to families included in the syllabus from fresh specimens, herbarium or preserved materials. After identification up to family level any suitable regional Flora may be provided for generic identification if required.	15
2	Description of a species based on various specimens to study intraspecific variation.	15
3	Studies to find out the location of key characters and preparation of keys at generic level.	15

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4	Field trips, compilation of field notes, the preparation of herbarium sheets and submission of herbarium and museum specimens and/or live potted specimens of taxonomic interest and submission of the excursion report.	15
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Suggested Readings

Rajan Sundara, S. (2021). Practical Manual of Angiosperm Taxonomy. Anmol Publication Pvt. Ltd.

BOTDE709 Research Methodology (For Honours with research)

Credit 3

Course outcomes:

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

1. Remember various kind of research, objectives of doing research, research process and research design.
2. Understand the ability to choose methods appropriate to research aims and objectives.
3. Apply skills to analyse data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
4. Analyse statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
5. Evaluating the properties of mechanism of research methodology.
6. Constructing the research methodology for report writing.

Unit	Topic	Total No. of lecturers/hrs (45)
1	Meaning & Functions of Research Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.	12
2	Research Problem and Research Design Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.	10

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3	<p>Interpretation and Report Writing</p> <p>Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report</p>	10
4	<p>Statistical Techniques and Tools -I</p> <p>Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution.</p> <p>Statistical Techniques and Tools -II: Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)</p>	13

Suggested readings:

1. Kothari C.R., Research Methodology Methods & Techniques, New Age international Publishers.
2. Gupta G. and Gupta M., Research Methodology, PHI Learning Private Ltd.
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical statistics, , Sultan Chand & Sons, New Delhi.

PRACTICAL/ LAB course
BOTDL710 Lab Course Based (For Honours only) Credit 1

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4	Field trips, compilation of field notes, the preparation of herbarium sheets and submission of herbarium and museum specimens and/or live potted specimens of taxonomic interest and submission of the excursion report.	15
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Suggested Readings

Rajan Sundara, S. (2021). Practical Manual of Angiosperm Taxonomy. Anmol Publication Pvt. Ltd.

**Discipline Specific Elective
SEMESTER-VIII
Plant Health Management
BOTDE803**

- Course Outcome:** After the completion of the course the students will be able to
1. Remember the terms associated with plant health management and basic procedure of diagnosis and significance of plant diseases.
 2. Understand the concepts of seed pathology and learn defense mechanism in plants
 3. Explain and illustrate the important of plant diseases with reference to Nursery, cash crops.
 4. Explain and identify the important diseases of plantation.
 5. Summarized and address the various types of mycorrhizal associations and their role in forestry.
 6. Generalize and write the diseases of cereals, millets, vegetables and fruit trees.

Unit	Topic	Total No. of lecturers/hrs (45)
1	Basic procedure in diagnosis of plant diseases: Significance of plant diseases. Seed Pathology: Seed borne fungi. Disease transmitted through seeds. Biodeterioration of seed in storage. Control of seed borne fungi.	10
2	Nursery disease: Important disease of nursery plants. Plantation disease: Plantation disease of Chir pine, Eucalyptus, Sal, Teak, Shisam, Populus, Acacia (Catechu).	10
3	Important disease of cash crops: Sugarcane, Potato and Ginger. How plants defend themselves against pathogen. Control of crop and forest disease. Treatment of wounds. Introduction and various forms of Mycorrhiza. Role of Mycorrhiza in Forestry	15
4	Diseases of cereals, millets, vegetables and fruit trees	10

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Suggested Readings

1. Bilgrami, K.S. 1985. Text Book of Modern Plant Pathology. Bishen Singh Mahendra Pal Singh Dehradun.
2. Butler, E.J. 1973. Fungi and Disease in Plants, Intern, Book Distributers. Dehradun.
3. Singh, R.S. 1983. Plants Diseases. Oxford and IBH Publ. Co. New Delhi.
4. Singh, R.S. Principle of Plants Pathology. Oxford and IBH Publ. Co. New Delhi
5. Strobel, G.A. and D.E., Mathre 1970. Outlines of Plant Pathology. Van Nostrand Reinhold Co. New York.
6. Tarr, S.A.J. 1972. The Principle of Plants Pathology. Winchester Press, New York.
7. Western, J.H. 1971. Diseases of Crop Plants. Mc Millan Press, London

Practical/Lab Course BOTDL804

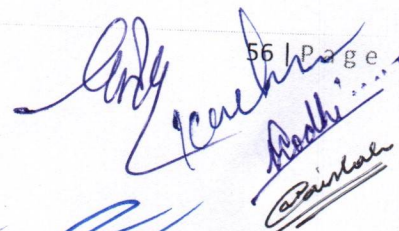
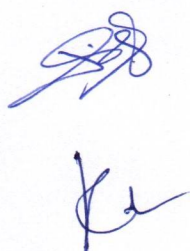
Course Outcome:

1. Remember the fundamentals of Plant Diseases.
2. Understand Symptoms, causes, etiology of the pathogen.
3. Apply seed soak method for the detection of seed borne pathogen
4. Analyze and Isolate some important plant pathogen.
5. Evaluate and Isolation of Fungi/bacteria by the Pour- plate method, Spread-pate and Streak Plate method
6. Test the presence of pathogen in diseased plant

Unit	Topic	Lecture Hours (60)
1	Study of seed borne pathogen. Description of pathogen, symptoms and section cutting	15
2	Isolation of some important pathogens. Procedure of equipment uses.	15
3	To establish a plant disease clinic in the department for advise to local people.	8
4	Diseases of crops, plantation crops, fruit trees through specimens	7

Suggested Readings

- Husain Hadi Khan et al. 2019. Practical Lab manual for microbiology and plant pathology, Akinik Publication, Delhi.
- Aneja, K.R. 2016. Experiments in Microbiology, Plant Pathology, Tissue Culture and Biotechnology, New Age International Publisher.



Genetics, Plant Breeding and IPR BOTDE805

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

1. Remember the concept of Mendelian and non-Mendelian inheritance, quantitative genetics, molecular markers and linkage mapping, prokaryotic and eukaryotic genome structure, gene function and regulation, epigenetics, cytogenetics.
2. Understand to integrate molecular methods with conventional improvement strategies to accelerate plant breeding.
3. Apply to gain knowledge on commercially important plants, their breeding systems and strategies employed for crop improvement.
4. Analyze the basic concepts of intellectual property rights.
5. Evaluate the procedure for obtaining the intellectual property rights.
6. Generalized the concept of Genetics, Plant Breeding and IPR

Unit	Topic	Total No. of lecturers/hrs (45)
1	Principles of inheritance: Mendelian laws along with molecular explanations, Exceptions to Mendelian laws, lethal alleles and Gene Interactions. Structural and numerical alterations in chromosomes: Origin, occurrence, production and meiosis of haploids, aneuploids and euploids, induction and characterization of trisomics and monosomics.	8
2	Genetics of prokaryotes and eukaryotic organelles: genetic recombination of phage; genetic transportation, conjugation and transduction in bacteria, cytoplasmic male sterility. Gene structure and expression: Genetic fine structure, cis-trans test; fine structure analysis of eukaryotes, introns and their significance, regulation of gene expression in prokaryotes and eukaryotes. DNA damage and repair mechanism, defects in DNA repair; Initiation of cancer at cellular level, proto oncogenes and oncogenes.	10

57 Page

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3	Genetic recombination and genetic mapping: Recombination; independent assortment and crossing over, linkage groups, genetic markers, construction of molecular maps. Mutations: Spontaneous and induced mutations; physical and chemical mutation, molecular basis of gene mutation; mutations induced by transposons.	7
4	The role of plant breeding – historical aspects and genetic basis: mode of reproduction in relation to breeding methods, breeding techniques; method of plant breeding in relation to self-pollinated and cross pollinated plants. Hybridization: Interspecific and inter generic; pure line; back cross hybridization; self- incompatibility system. Breeding for resistance to diseases, physiological races. Plant breeding work done in India with special reference to potato, paddy, wheat and sugarcane. Maintenance of collection, registration of varieties, seed production, testing, certification and distribution.	10
5	Introduction to intellectual property right (IPR) Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR, WTO TRIPS and WIPO. Patents Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents, Infringement. Copyrights: Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement. Trademarks: Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name	10

Suggested Readings

1. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
2. Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
3. P.K Gupta. 2016. Genetics. Rastogi Publication, Meerut.
4. B.D. Singh. 2018. Genetics and Plant Breeding. Kalyani Publisher, New Delhi.
5. Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw Hill Publ. Co. Ltd. New Delhi.
6. N.K. Acharya (2001). Textbook on intellectual property rights, Asia Law House.
7. Manjula Guru and M.B. Rao (2003). Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
8. P. Ganguli (2001). Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
9. Miller, A.R. and Davis M.H. (2000). Intellectual Property: Patents, Trademarks and Copyright in Nutshell, West Group Publishers.

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Practical/Lab Course
BOTDL806

Course Outcome:

1. Recall the knowledge of terms associated with Genetics and Plant Breeding
2. Understand the process of sex-linked inheritance
3. Apply knowledge to study floral biology of crops
4. Analyze applications of common plant breeding techniques
5. Evaluate dockage and purity percent of seed
6. Solve problems related to genetics and plant breeding.

Unit	Topic	Total No. of lecturers/hrs (60)
1	Genetical problem son Mendelian and post- Mendelian ratios, gene interactions, sex-linked inheritance, chromosomal mapping, etc	20
2	Application of common plant breeding techniques	8
3	Identification of Indian varieties of important crops. Floral biology of local food, pulse, vegetable and horticultural crops.	10
4	Collection of germplsm of different crops being grown in the area. Seed germination, dockage, purity percentage	7

Suggested Readings

Singh, B.D. 2016. Principles of Genetics and Plant Breeding. Kalyani Publisher, New, Delhi Freshwater Algal Flora of Himalaya

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- Vuuren, V.J.S., Taylor, J., Gerber, A., Van Ginkei, C. (2006). Easy identification of the most common Fresh water Algae. A guide for the identification of microscopic algae in South African Fresh waters, Publ. by North West University, Potchefstroom, p212.

**Practical/Lab Course
BOTDL808**

Course Outcome:

1. Recall the knowledge of different genera of algae.
2. Understand about the members belong to different classes of algae
3. Develop the Cultivation of algae of commercial importance
4. Analyze or Differentiate different groups of algae
5. Evaluate methods of identification of Himalayan flora
6. Create methods to isolate fresh water algae

Unit	Topic	Lecture Hours (60)
1	Cultivation of algae of commercial importance. Study of representative genera of different families viz., Melosira, Cyclotella, Fragilaria, Diatoma, Meridion, Achnantheidium, Cocconeis, Navicula & Cymbella, Gomphonema, Diploneis, Pinnularia, Caloneis, Nitzschia, Denticula, Green and Blue-Green Algae	30
2	Collection and Diversity of algae in lotic and lentic water streams of Himalayan region and their documentation	30

Suggested Readings

Bellinger, E.G., Sigeo, D.C. (2010) Freshwater Algae (Identification and Use as Bioindicators). Wiley-Blackwell, pp1-243.

Vuuren, V.J.S., Taylor, J., Gerber, A., Van Ginkei, C. (2006). Easy identification of the most common Fresh water Algae. A guide for the identification of microscopic algae in South African Fresh waters, Publ. by North West University, Potchefstroom, p212.

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BOTDE809 Research Publication and Ethics Semester (For Honours with research) Credit 3

Course outcomes:

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

Course Outcome

- Remember the basics of philosophy of science with research ethics
- Familiarize with important issues in research ethics, integrity & scientific misconduct
- Analyse the best practices for publications, publication ethics and identify the predatory, publishers & journals.
- Applying the study related to the use plagiarism software tools, citation databases and research metrics.
- Evaluating the properties of mechanism of Research Publication and Ethics
- Constructing the Research Publication and Ethics

Unit	Topic	Total No. of lecturers/hrs (45)
1	<p>Meaning & Functions of Research</p> <p>Philosophy: Definition, introduction of concept, branches of Philosophy, Introduction of Metaphysics, Epistemology, Ethics/ Moral, Political and Aesthetics Philosophy Moral philosophy, nature of moral judgments and reactions</p>	12
2	<p>Research Problem and Research Design</p> <p>Ethics: Definition with respect to science and research, Intellectual honesty and research integrity</p> <p>Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data</p>	10
3	<p>Interpretation and Report Writing</p> <p>Publication ethics: Definition, introduction and importance, Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: Definition, concept, Introduction about authorship and contributorship, Violation of Publication Ethics, Identification of publication, complaints and appeals</p>	10

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4	Statistical Techniques and Tools -I Introduction about Journals & Publishers, Predatory publishers and journals, Quality of Journals & Publication, Introduction about Scopus/SCI, eSCI/Web of Science Indexing (Scopus.com) etc., Software tool to identify predatory publications developed by SPPU Plagiarism tools , Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.	13
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Suggested readings:

1. Dutta, Sumanta, Research and Publication Ethics, Bharti Publications.
2. Yadav S.K., Research and Publication Ethics, Anne Publications.

PRACTICAL/ LAB course
BOTDL810 Lab Course Based (For Honours only) Credit 1

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Generic Electives
SEMESTER-I
Plant Science-I (BOTGE103)

Course Outcome

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

1. Remember: Define, Recall, select and recognize about the diversity of different microbes including viruses, Algae, Fungi, bryophytes, Pteridophytes.
2. Understanding: Develop, describe, classify and discuss understanding about the classification and diversity of different microbes including viruses, Algae, Fungi, bryophytes, pteridophytes & their economic importance and the structure and reproduction of certain selected bacteria, algae, fungi, bryophytes, Pteridophytes.
3. Apply: Explain morphology, anatomy and reproduction of Bryophytes. Pteridophytes. Thallus organization, classification, vegetative structure and Life cycles of microbes, algae & fungi and bryophytes.
4. Analyzing: Explain, differentiate or classify conceptual skill about identifying microbes, and pathogens.
5. Evaluating: Summarize, distinguish or conclude knowledge about developing commercial enterprise of microbial products. Host –pathogen relationship and disease management.
6. Creating: Construct, develop, generalize, prepare and write about uses of microbes, fungi, algae, bryophytes, Pteridophytes.

Unit	Topic	Lecture (Hours)
		45
1	Microbes: General characteristics and economic importance of bacteria and viruses. Algae: General characteristics; range of thallus, reproduction and economic importance Fungi: General characteristics, reproduction, ecology and significance.	20
2	Bryophytes: General characteristics, adaptations to land habit, reproduction and economic importance of bryophytes. Pteridophytes: General characteristics, ecological and economic importance of Pteridophytes.	25

Suggested Readings

Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
Pandey, S.N and Trivedi, P.S. (2015). A text book of Botany Vol.I Vikas publishing House Pvt/ Ltd, New Delhi.
Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Bryophyta, S. Chand. Delhi, India..



Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Pteridophyta, S Chand and Company Ltd., Ramnagar, New Delhi, India.

SEMESTER-II

Plant Science-II (BOTGE203)

Course Outcome

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

1. Remember: Define, Recall, select and recognize about the gymnosperm and Lichens & their economic importance. Anatomy and Embryology of plants
2. Understanding: Develop, describe, classify and discuss understanding about the classification and diversity of gymnosperm & their economic importance and the structure and reproduction of lichens. Basic concept of plant taxonomy, morphology, anatomy and embryology.
3. Apply: Explain morphology, anatomy and reproduction of Gymnosperms.
4. Analyzing: Explain, differentiate or classify conceptual skill about lichens. Adaptive anatomy in hydrophytes and xerophytes.
5. Evaluating: Summarize, distinguish or conclude knowledge about Morphology, anatomy and embryology.
6. Creating: Construct, develop, generalize, prepare and write about uses of gymnosperms and angiosperms in various fields.

Unit	Topic	Lecture (Hours) 45
1	Gymnosperms: General characteristics, ecological and economic importance. Lichens, Introduction to plant taxonomy: Identification, classification, nomenclature, functions of herbarium, important herbaria and botanical gardens of the world and India.	20
2	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.	25

Suggested Readings

- Parihar, N.S. (1991). An Introduction to Embryophyta Vol. I Bryophyta. Central Book Depot, Allahabad. Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Gymnosperms, S Chand and Company Ltd., Ramnagar, New Delhi, India.
- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.

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- Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford and IBH Pvt. Ltd., New Delhi. 3rd edition. Gangulee H.C., Kar, A.K. and Santra S.C. (2011). College Botany Vol II. 4th Edition New Central Book Agency.
- Pandey, B.P. (2010). College Botany Vol II. S. Chand and Company Ltd., New Delhi, India.

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SEMESTER-III
Plant Science-III (BOTGE303)

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

1. Define basic concept of physiology, biochemistry, plant biotechnology.
2. Understand the basic biochemical and physiological process in plants.
3. Explain the basic of plant tissue culture techniques used in molecular biology.
4. Correlate the concept of RDT in Plant Biotechnology.
5. Summarize the concepts of Photosynthesis.
6. Generalize the concept of Plant Physiology and Plant Biotechnology

S.No.	Topics	Lecture (Hours) 45
1	Plant Physiology: Photosynthesis, Respiration, Nitrogen Fixation.	15
2	Biochemistry: carbohydrates, proteins, lipids and secondary metabolites.	15
3	Plant Biotechnology: Plant tissue culture, recombinant DNA technology and Techniques used in molecular biology.	15

Suggested Readings

- Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
- Dubey, R.C. 2018. A textbook of Biotechnology. S. Chand Publ., New Delhi.


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SEMESTER-IV

Plant Science-IV (BOTGE403)

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

1. Define basic concept of environment and ecology, breeding, and economically important plants.
2. Understand the importance, benefits and services of biodiversity
3. Explain and apply process of conservation of biodiversity.
4. Correlate the concept of biodiversity and its conservation and global warming.
5. Summarize the concepts of Mendelian genetics, plant breeding methods, crop evolution and uses of plants.
6. Generalize the concept of plant sciences

S.No.	Topics	Lecture (Hours)
1	Biodiversity and Conservation: Species, population, species interaction, ecosystem, ecological succession, environment pollution, biodiversity, In situ and ex situ conservation, International Union for Conservation of Nature (IUCN), and Climate change and its consequence.	25
2	Plant Breeding and Utilization: Mendelian principles, plant breeding methods, and evolution of major crop plants, economics and utilization of plant resources.	20

Suggested Readings

- Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity – Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
- B.D. Singh. 2018. Genetics and Plant Breeding. Kalyani Publisher, New Delhi.
- Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw Hill Publ. Co. Ltd. New Delhi.

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SEMESTER-V

Medicinal Plant Diversity of Uttarakhand (BOTGE505)

Course outcomes:

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

- Define various types of medicines with their functions.
- Understand the diversity and distribution of medicinal plants in Uttarakhand 9. Apply the techniques/methods for the sustainable utilization of the medicinal plants.
- Analyze the economic importance of medicinal plants.
- Summarize the botanical name, family and plant parts used for human welfare.
- Create green house for nursery preparation of medicinal plants

Unit	Topic	Total No. of lecturers/ hrs (45)
1	Retrospect and prospects of medicinal plants	5
2	Brief history, properties, action and uses of some important medicinal plants Diversity, distribution and indigenous uses of threatened medicinal plants	15
3	Policies for threatened medicinal plant conservation and management marketing of medicinal plants	15
4	Economics and exploitation of resources and people conflict	10

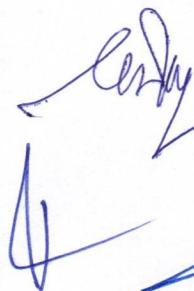
Suggested readings

- Arber, A. (1999). Herbal plants and Drugs. Mangal Deep Publications.
- 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.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Tree, shrubs and Climbers. Vol. I. Gyandodaya Prakashan, Nainital.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Herbs, Grasses and Ferns. Vol. II. Gyandodaya Prakashan, Nainital.

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ABILITY ENHANCEMENT COURSES

SEMESTER-I

Environment Science-I

AEC-104

Course Outcome:

1. Discover knowledge in ecological perspective and value of environment.
2. Understand the significance of various natural resources and its management
3. Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
4. Categorize different types of pollutions and their control measures. Discover effective methods of waste Management
5. Evaluate global environmental problems and come out with best possible solutions. 6. Create environmental laws and sustainable development

Unit	Topic	Lecture Hours (45)
1	Environment: Definition, scope and importance of environment, need for public awareness; Ecosystem: Definition, scope and importance of ecosystem, classification, structure and function of an ecosystem, food chains, food web and ecological pyramids, flow of energy	10
2	Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems	10
3	Biodiversity and biotic resources: Introduction, definition, genetic, species and ecosystem diversity; Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and optional values; India as a mega diversity nation; Endangered and Endemic species, Hot spots of biodiversity	10
4	Environmental pollution: Definition, causes and effects of air pollution, water pollution, soil pollution, noise pollution	8
5	Environmental legislations: Environmental protection act, air act1981, water act, forest act.	7

Suggested Readings

1. Benny Joseph, "Environmental Studies", Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1st Edition, 2006.
2. Erach Bharucha, "Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition, 2013.
3. Dr. P. D Sharma, "Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition, 201

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SEMESTER-II
Environment Science-II
AEC-204

Course Outcome

1. Discover knowledge in ecological perspective and value of environment.
2. Understand the significance of various natural resources and its management
3. Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
4. Categorize different types of pollutions and their control measures. Discover effective methods of waste Management
5. Evaluate global environmental problems and come out with best possible solutions. 6. Create environmental laws and sustainable development

Unit	Topic	Lecture Hours (45)
1	Environment: Biogeochemical cycles Hydrological cycle, Phosphorous cycle, Nitrogen cycle	4
2	Natural resources: Mineral resources: Use and exploitation; Land resources; Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies	8
3	Biodiversity and biotic resources: Threats to biodiversity: Habitat loss, poaching of wildlife, human-wildlife conflicts; Conservation of biodiversity: In situ and ex situ conservation; National biodiversity act.	8
4	Environmental pollution: Solid waste: Municipal solid waste management, composition and characteristics of e-waste and its management; Pollution control technologies: Waste water treatment methods, primary, secondary and tertiary; Concepts of bioremediation; Global environmental problems and global efforts: Global Warming, Climate change, Sea level rise, ozone depletion, ozone depleting substances, deforestation and desertification; International conventions / protocols: Earth summit, Kyoto protocol and Montreal protocol	15
5	Environmental legislations: Municipal solid waste management and handling rules, biomedical waste management and handling rules 2016, hazardous waste management and handling rules, Environmental impact assessment(EIA); Towards sustainable future: Concept of sustainable development, population and its explosion, crazy consumerism, environmental education, urban sprawl, concept of green building	10

Suggested Readings

- Benny Joseph, "Environmental Studies", Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1st Edition, 2006.



- Erach Bharucha, "Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition, 2013.
- Dr. P. D Sharma, "Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition, 201

SEMESTER-III
English Communication-I
AEC304

Course Outcomes

1. Remember the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.
2. Understand and remember the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
3. Applying, understanding and remembering the detailed processes of essential techniques and features of effective writing and make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible writing.
4. Analyzing, applying, remembering, understanding the detailed study related common errors in English and solve exercises based on them; apply acquired knowledge and skills of oral and written communication in personal and professional life.
5. Evaluating, analyzing, applying, remembering, and understanding the use of English grammar.
6. Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in individual and group communication activities; and determine and invent new forms and methods of communication to as per the situation.

Unit	Topic	Lecture Hours (45)
1	Theory of Communication, Types and Modes of Communication: Introduction, Definitions and Function of Communication, Needs for Effective Communication	15
2	Listening Skills: Types of Listening, Developing Effective Listening Skills, Academic Listening (Lectures)	10
3	Reading Skills: Skimming, Scanning, Summary, Paraphrasing, Comprehension.	10
4	Introductory English Grammar: Parts of Speech, Tenses, Punctuation, Common Errors in English.	10

Suggested Readings

1. Fluency in English- Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. RanjhanaKaul, Dr. Brati Biswas.

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SEMESTER-IV
English Communication-II
AEC304

Course Outcomes

- Remember the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.
- Understand and remember the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
- Applying, understanding and remembering the detailed processes of essential techniques and features of effective writing and make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible writing.
- Analyzing, applying, remembering, understanding the detailed study related common errors in English and solve exercises based on them; apply acquired knowledge and skills of oral and written communication in personal and professional life.
- Evaluating, analyzing, applying, remembering, and understanding the use of English grammar.
- Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in individual and group communication activities; and determine and invent new forms and methods of communication to as per the situation.

Unit	Topic	Lecture Hours (45)
1	Process of Communication, Barrier to Communication, Kinds of Communication; Intrapersonal, Personal, Group and Mass, Verbal and Non-verbal Communication	15
2	Listening and Speaking Skills: Listening to Talks and Presentation, Monologue, Dialogue, Group Discussion, Miscommunication, Interview, Public Speech, Pronunciation, Accent and Intonation and Rhythm.	10
3	Writing Skills; Social and Official Correspondence: Enquiries, Complaints and Replies, Letters to the Editor, Social Appeals in the Form of Letter/ Pamphlets, Standard Business Letter, Email Drafting and Etiquettes, Preparing Agenda and Writing Minutes for Meetings.	10
4	Career Skills: Job Application, Cover Letter, Bio-data, CV and Resume and Effective Profiling, Mock Interviews, Group Discussions.	10

Suggested Readings

1. Fluency in English- Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. RanjhanaKaul, Dr. Brati Biswas.

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SKILL ENHANCEMENT COURSES

SEMESTER-I

Nursery and Gardening

BOTSC105

Course Outcomes:

1. Describe the objectives and scope of Nursery, Gardening and cultivation of various vegetables.
2. Explain about the structure and types of seed, seed dormancy, Seed production technology, seed testing and certification etc.
3. Illustrate the methods of Nursery, Gardening and vegetative propagation.
4. Analyze the definition, objectives and scope of different types of Nursery & gardening
5. Summarized the knowledge sowing and raising of seeds and seedlings, transplanting and cultivation of seedlings and marketing procedures of vegetables.
6. Design the idea of Nursery and Gardening.

Unit	Topic	No. of lecturers/ hrs (45)
1	Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities – Planting – direct seeding and transplants. Seed: Structure and types – Seed dormancy; causes and methods of breaking dormancy-Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology – seed testing and certification	8
2	Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings – Hardening of plants – green house – mist chamber, shed root, shade house and glass house	6
3	Gardening: definition, objectives and scope – different types of gardening- landscape and home gardening – parks and its components – plant materials and design-computer applications in landscaping – Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.	8
4	Sowing/raising of seeds and seedlings – Transplanting of seedlings – Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots – Storage and marketing procedures. National and state institutes related to the activity.	8

Suggested readings

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

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SEMESTER-III

Biofertilizers

BOTSC305

Course Outcomes:

1. Remember the knowledge of classification, characteristics and culture maintenance of Rhizobium and Azotobacter, green manuring, organic fertilizers
2. Understanding about the green manuring, organic fertilizers, , characteristics and culture maintenance of Rhizobium and Azotobacter, Mycorrhizal association
3. Applying the knowledge about the role of Mycorrhizal associations in influencing the growth and yield of crop plants, isolation, identification, mass multiplication of Biofertilizers.
4. Analyze the General account about the microbes used as Biofertilizer
5. Summarized the recycling of biodegradable waste materials, methods of making biocompost and vermicomposts.
6. Create the idea of making Biofertilizers.

Unit	Topic	No. of lecturers/ hrs (45)
1	General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.	10
2	Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.	10
3	Cyanobacteria (blue green algae), Azolla and Anabaena azolla association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation	5
4	Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.	10

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5	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application	10
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Suggested Readings

- Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan,Nadiad
- Acharya, Sen and Rai. (2019). Biofertilizers and Biopesticides. Techno World Press

Ethnobotany BOTSC405

Course Outcome:

1. Knowledge about history, concept, scope and relevance of herbal drugs in Indian system of medicine
2. Understand the techniques for drug evaluation (Chemical, Physical and Biological), Phytochemical investigations, standardization and quality control of herbal drugs
3. Apply the technique of medicinal gardening - Cultivation practices, marketing and utilization of selected medicinal plants
4. Analyze the macroscopic and microscopic characters, chemical constituents, adulterants, therapeutical and pharmaceutical uses of medicinal plants
5. Summarize the legal aspects of ethnobotanical studies
6. Collaborate ethnobotany to ethnic group.

Unit	Topic	No. of lecturers/ hrs (45)
1	Ethnobotany Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.	10
2	Methodology of Ethnobotanical studies a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.	7

3	Role of ethnobotany in modern Medicine Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) a) <i>Azadiracta indica</i> b) <i>Ocimum sanctum</i> c) <i>Vitex negundo</i> . d) <i>Gloriosa superba</i> e) <i>Tribulus terrestris</i> f) <i>Pongamia pinnata</i> g) <i>Cassia auriculata</i> h) <i>Indigofera tinctoria</i> . Role of ethnobotany in modern medicine with special example <i>Rauvolfia serpentina</i> , <i>Trichopus zeylanicus</i> , <i>Artemisia</i> , <i>Withania</i> .	12
4	Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management)	6
5	Ethnobotany and legal aspects Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.	10

Suggested Readings

- S.K. Jain (ed.) Glimpses of Indian. Ethnobotany, Oxford and I B H, New Delhi –1981.
- S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur
- Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996.

Mushroom Cultivation BOTSC506

Course Outcome:

1. Remember the history and scope of mushroom cultivation
2. Understand the economic importance of mushroom cultivation
3. Apply the basic tools and techniques used in mushroom cultivation
4. Analyze about the cost benefit ratio, marketing in India and abroad and export value of Mushroom
5. Evaluate and measure about processing of edible mushrooms.
6. Generalize the skills for developing commercial enterprise of mushroom cultivation

Unit	Topic	No. of lecturers/ hrs (45)
1	Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India – <i>Volvariella volvacea</i> , <i>Pleurotus citrinopileatus</i> , <i>Agaricus bisporus</i>	10

2	Cultivation methods: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, composting technology in mushroom production	15
3	Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.	10
4	Food Preparation_: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.	10

Suggested Readings

- Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
- Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol.II.

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SEMESTER-VI
Herbal Technology
BOTSC606

Course Outcome:

1. Remember and define role of medicinal plants, their cultivation, harvesting, processing, storage, marketing and utilization.
2. Understand uses of herbs in curing various ailments.
3. Explain phytochemistry of medicinal plants.
4. Analyze the systematic position and medicinal uses of some important plants like Tulsi, Ginger, Fenugreek, Indian Goose Berry and Ashoka.
5. Evaluate drug adulteration- types and methods of drug evaluation biological testing of herbal drugs for secondary metabolites
6. Plan or prepare to cultivate medicinal plants in lab through micropropagation

Unit	Topic	No. of lecturers/ hrs (45)
1	Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Ayurveda/Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.	8
2	Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka	8
3	Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; <i>Catharanthus roseus</i> (cardiotonic), <i>Withania somnifera</i> (drugs acting on nervous system), <i>Clerodendron phlomoides</i> (anti-rheumatic) and <i>Centella asiatica</i> (memory booster).	12
4	Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)	13
5	Medicinal plant banks micro propagation of important species (<i>Withania somnifera</i> , neem and tulsi- Herbal foods-future of pharmacognosy)	4



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Suggested Reading

Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, NewDelhi.

Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications

Ayurvedic drugs and their plant source. V.V. Sivarajan and BalachandranIndra 1994. Oxford IBH _publishing Co.

DISSERTATION SEMESTER-VII & VIII Dissertation on Major Core/Minor Elective (from VII & VIII Semester papers) OR Academic Project/ Entrepreneurship

Course Outcome:

1. Remember the subject knowledge.
2. Discuss and understand the scientific temperament.
3. Apply the fundamentals of research methodology.
4. Focus on the skills for the writing of thesis and scientific papers
5. Justify the knowledge of course work.
6. Create awareness and interest towards research.

Course contents: The student will be reading and analyzing published literature in the chosen area of plant science under direct mentoring of a faculty member and will participate in research activity

