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 /
Bachelor of Science (Hons.) in Botany /
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 2023-2024
(Revised on 30th July, 2024 & 12th August, 2025)

Patel Nagar, Dehradun, Uttarakhand

Basic Structure of UG Multidisciplinary Programme (with Three Core Disciplines) – B.Sc. (Bachelor of Science) 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 Enhancement Course (AEC)	Skill Enhancement Course (SEC)	(Internship /Apprenticeship / 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**
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 B 1 (Zoology) (4)** **DSC C 1(Chemistry) (4)** (3T+1L)	Choose one from a pool of courses, **DSE 3 (A/B/C (4** credits) (3T+1L/or 2T+2L) OR **MOOC**	Choose one from a pool of Courses, **GE – 6 (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 B1 (Zoology) (4)** **DSC C1 (Chemistry) (4)** (3T+1L)	Choose one from a pool of courses, **DSE 4 A/B/C (4 credits)** (3T+1L/or 2T+2L) OR **MOOC**	Choose one from a pool of Courses, **GE – 6 (4)** OR **MOOC**	Choose one from **SEC 6 – (2)** OR **Internship/Apprenticeship /Project/Community Outreach (IAPC) – (2)**		22
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) OR Academic Project/Entrepreneurship (4+2) [B.Sc. Hons with Research] OR DSC A-4 Seminar 2 [B.Sc. Honors]		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) OR Academic Project/Entrepreneurship (4+2) [B.Sc. Hons with Research] OR DSCA-4 Seminar 2 [B.Sc. Honous]		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**

Course Introduction:

The new curriculum of B.Sc. (Bachelor of Science) 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. (Bachelor of Science) [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. (Bachelor of Science) [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. (Bachelor of Science) 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

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. (Bachelor of 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.

Program –specific Outcomes (POs):

PSO- 1	This certificate course will provide knowledge of various fields of basic Botany. The syllabus is prepared to enable students for competitive exams in frontier areas of plant sciences. Students will be able to know about the habits, habitat, morphology, anatomy, and reproduction of various plant groups.
PSO- 2	This program will provide knowledge of plant anatomy, embryology, and Cytogenetic. Laboratory sessions following theory will provide an easy Understanding of the internal structure of various plant parts, structural organization, reproductive biology, and genetics. This course will help students to become plant morphologists
PSO- 3	The three-year learning outcome of graduation will provide an Understanding of plant systematics, developmental biology, ecology, statistics, physiology, biochemistry, anatomy, and plant genetics. It will provide expertise in conservation biology and reproduction biology. After completing this course successfully, students will be able to contribute in the field of plant sciences. The research project will help to develop research aptitude for higher education and scientific research.
PSO- 4	The four-year program help students to pursue a career as Nursery managers, ecologist, and conservationist in many firms, Plant explorer in governmental and non- governmental organizations, park ranger, good researcher, plant pathologists, a microbiologist, and breeding scientist in national laboratories. It is beneficial for students that they can work in different industries and National institutes and organizations for the demand of society and for sustainable utilization.

Credit Requirements and Qualifications at different levels on the NHEQF:

Credit Requirements and Qualifications at different levels on the NHEQF: The level of the four years B.Sc. Programme shall be as per the Draft National Higher Educational Qualification Framework (NHEQF). As per the guidelines, the numbers of credits to be earned at each level are as under:

NHEQF Level	Nomenclature (qualifications within each level)	Credit earned without exit option	Credit earned with exit option
Level – 5	**Undergraduate Certificate** for those who exit after successful completion of first year (two semesters) of the undergraduate programme	**44**	**48**
Level – 6	**Undergraduate Diploma** for those who exit after successful completion of second year (four semesters) of the undergraduate programme	**88**	**92**
Level – 7	**Bachelor's Degree** for those who exit after successful completion of three years (six semesters) of the four-year undergraduate programme	**132**	**132**
Level – 8	**Bachelor's Degree with Honours** for those who have successfully completed four years (eight semesters) of the undergraduate programme	**176**	**176**
Level – 8	**Bachelor's Degree Hons. with Research** for those who have successfully completed four years (eight semesters) of the undergraduate programme	**176**	**176**

Examination Scheme:

Components	Ist Internal Presentation/ Assignment/ Project	IInd Internal Presentation/ Assignment/ Project	External (ESE)
Weightage (%)	15 Marks	15 Marks	70 Marks

COURSE STRUCTURE

Semester Wise Discipline Specific Core for B.Sc. (Hons with research)

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	DSC(Botany)	BOTDC101	Microbes, Algae, Fungi, and Bryophytes	3	0	0	3
		BOTDL102	Lab Course (based on BOTDC101)	0	0	2	1
II		BOTDC201	Pteridophytes, Gymnosperms and plant taxonomy	3	0	0	3
		BOTDL202	Lab course (based on BOTDC201)	0	0	2	1
III		BOTDC301	Morphology and Anatomy	3	0	0	3
		BOTDL302	Lab course (based on BOTDC301)	0	0	2	1
IV		BOTDC401	Embryology and Cytogenetics	3	0	0	3
		BOTDL402	Lab course (based on BOTDC401)	0	0	2	1
V		BOTDC501	Economic Botany and Plant Breeding	3	0	0	3
		BOTDL502	Lab course (based on BOTDC501)	0	0	2	1
VI		BOTDC601	Physiology and Biochemistry	3	0	0	3
		BOTDL602	Lab course (based on BOTDC601)	0	0	2	1
VII		BOTDC701	Plant Pathology and Plant Health Management	3	0	0	3
		BOTDL702	Lab Course (based on BOTDC701)	0	0	2	1
VIII		BOTDC801	Ecology and Biostatistics	3	0	0	3
		BOTDL802	Lab Course (based on BOTDC801)	0	0	2	1

Semester Wise Discipline-Specific Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
III	DSE(Botany)	BOTDE303	Analytical Techniques in Plant Sciences	3	0	0	3
		BOTDL304	Lab Course (based on BOTDE303)	0	0	2	1
IV		BOTDE403	Introduction to Medicinal and Aromatic plants	3	0	0	3
		BOTDL404	Lab Course (based on BOTDE403)	0	0	2	1
V		BOTDE503	Cell and Molecular Biology & Plant Biotechnology	3	0	0	3
		BOTDL504	Lab course(based on BOTDE503)	0	0	2	1
VI		BOTDE603	Palynology and Pollination Biology	3	0	0	3
		BOTDL604	Lab course (based on BOTDE603)	0	0	2	1
VII (The student has to choose any four (for Hons)/three (for Hons. with res.)elective theory papers and lab course based on it)		BOTDE703	Plant Resource Utilization and Conservation	3	0	0	3
		BOTDL704	Lab course (based on BOTDE703)	0	0	2	1
		BOTDE705	Microbiology	3	0	0	3
		BOTDL706	Lab course (based on BOTDE705)	0	0	2	1
		BOTDE707	Taxonomy and Diversity of Flowering Plants	3	0	0	3
		BOTDL708	Lab course (based on BOTDE707)	0	0	2	1
		BOTDE709	Seed Technology	3	0	0	3
		BOTDL710	Lab Course (based on BOTDE709)	0	0	2	1
		BOTDE711	Research Methodology*	3	1	0	4

III (The student has to choose any four (for hons)/three (for Hons with res.)elective theory papers and lab course based on it)		BOTDE803	Mycology	3	0	0	3
		BOTDL804	Lab course (based on BOTDE803)	0	0	2	1
		BOTDE805	Genetics, Plant Breeding and IPR	3	0	0	3
		BOTDL806	Lab course (based on BOTDE805)	0	0	2	1
		BOTDE807	Freshwater algal flora of Himalaya	3	0	0	3
		BOTDL808	Lab course (based on BOTDE807)	0	0	2	1
		BOTDE809	Environment Microbiology	3	0	0	3
		BOTDL810	Lab Course (based on BOTDE809)	0	0	2	1
		BOTDE811	Research Publication and ethics*	3	1	0	4

Semester Wise Generic Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	GE (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 A bility 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	(a) Biofertilizers/ (b) Disaster Management 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 Seminar/Dissertation*

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	BOTDT712	Dissertation on Major Core/Minor Elective (from VII Semester papers) OR Academic Project/ Entrepreneurship			6	6
VII	IAPC	BOTDS713	Seminar (for Honors)	0	0	2	**2**
VIII	IAPC	BOTDT812	Dissertation on Major Core/Minor Elective (from VIII Semester papers) OR Academic Project/ Entrepreneurship			6	6
VIII	IAPC	BOTDS813	Seminar (for Honors)	0	0	2	**2**

Semester Wise Value Addition Courses (Choose one from a pool of VAC Courses) *

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	VAC	VAC 1	Indian Knowledge Systems	1		1	2

II	VAC	VAC 2	Science and Society	1		1	2
III	VAC	VAC 3	Swachh Bharat	1		1	2
IV	VAC	VAC 4	Tribes of Uttarakhand	1		1	2

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:

CO1	Define the characteristics of microbes including viruses, Algae, Fungi, bryophytes & Lichens.
CO2	Explain the classification and diversity of microbes including viruses, Algae, Fungi & Lichens.
CO3	Apply knowledge of the morphology, anatomy, and reproduction and life cycles of microbes, algae, fungi, and bryophytes.
CO4	Identify the conceptual skills about microbes, algae, fungi and bryophytes
CO5	Illustrate about microbes, algae, fungi and bryophytes
CO6	Compile knowledge about the uses of microbes, fungi, algae, and bryophytes in various fields.

Course Content

Unit	Topic	No. of lectures/ hours (45)
1	**Microbes :**Viruses and Bacteria- General account, Reproduction and Economic Importance	10
2	**Algae:** General characteristics; Classification, morphology and life-cycles of Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Sargassum; economic importance of algae.	10
3	**Fungi:** Introduction-general characteristics, nutrition, reproduction and Recent classification and economic importance; The life cycle of Rhizopus (Zygomycota), Penicillium (Ascomycota), Puccinia, Agaricus (Basidiomycota); Alternaria (Deutromycota), A General account of lichen and mycorrhizae	15
4	**Bryophytes:** General characteristics, classification (up to family), morphology, anatomy, and reproduction of Riccia, Marchantia, and Funaria; ecology and economic importance of bryophytes.	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. (2010). 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.
- Robert Edward Lee's "Phycology" Phycology. Colorado State University, USA. Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo
- Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	1	2	2	3	2	3	0	2	3	3	2	1	1	2	2	2
CO 2	2	0	2	0	1	0	1	3	2	0	3	1	3	1	1	3
CO 3	1	2	2	3	0	2	1	1	1	0	0	3	2	3	3	0
CO 4	1	3	0	2	1	1	2	0	3	2	2	0	3	0	0	3
CO 5	2	2	3	1	0	2	3	1	1	3	3	3	0	3	1	0
CO 6	3	1	2	2	3	1	0	3	1	1	2	2	2	2	1	1

Practical/Lab Course
BOTDL102

Course Outcomes:

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

CO1	List about instruments, techniques, lab etiquettes, and good lab practices for working in a microbiology laboratory.
CO2	Demonstrate morphology, anatomy, reproduction, and developmental changes in microbes.
CO3	Apply practical skills in the field and laboratory experiments in Microbiology and Pathology
CO4	Analyze skills for identifying microbes and using them for Industrial, Agriculture, and Environment purposes
CO5	Evaluate to identify algae, lichens, and plant pathogens along with their symbiotic and parasitic associations
CO6	Design small digital reports, pictures and videos related to microbes.

Course Content

Unit	Topic	No. of Lectures / hours (30)
1	Ems/Models of Viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle. Types of Bacteria from temporary/permanent slides/photographs; EM of bacterium; Gram staining technique	5
2	Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs/permanent slides), Oedogonium, Vaucheria, and Sargassum through temporary preparations and permanent slides/specimens	10
3	Rhizopus and Penicillium: Asexual stages from temporary mounts. Alternaria: Specimens/photographs and tease mounts. Puccinia: Herbarium specimens of Black Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on wheat and permanent slides of both the hosts. Agaricus: Specimens of button stage and full-grown mushroom. Lichens: Study of growth forms of lichens (crustose, foliose, and fruticose). Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs).	7
4	Marchantia and Riccia: Morphology of thallus, rhizoids, and scales, gemmae whole mount (all temporary slides), V.S antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). Funaria- Morphology, whole mount leaf, rhizoids, operculum, peristome, (temporary slides); permanent slides showing L.S capsule.	8

Suggested Reading

- Pandey, B.P. (2014). Modern Practical Botany Vol. I. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Purohit, S.D., Kundra, G. K. and Singhvi, A. (2013). Practical Botany (part I). Apex Publishing House Durga Nursery Road Udaipur, Rajasthan.
- Sambamurty, A.V.S.S. (2006). A textbook of algae. I.K International Publishing House, Pvt. Ltd.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	0	3	2	2	3	2	2	3	2	1	3	2	1	2
CO 2	3	3	1	3	1	2	0	3	2	2	0	1	3	0	3	1
CO 3	3	0	3	0	3	0	3	3	3	1	0	2	0	3	3	3
CO 4	3	3	0	2	1	2	0	3	3	2	2	3	3	0	3	3
CO 5	3	2	3	3	2	2	3	0	0	1	3	0	2	3	0	2
CO 6	3	1	2	2	3	2	1	3	1	1	1	2	2	2	1	3

Semester-II
Pteridophytes, Gymnosperms, and plant taxonomy: BOTDC201

Course Outcomes:

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

CO1	Define the diversity of different plants including pteridophytes and gymnosperms. Angiosperms and their economic importance.
CO2	Develop a critical Understanding of morphology, anatomy, reproduction and evolution of Pteridophytes, Gymnosperms, and Angiosperms.
CO3	Explain major patterns of plant diversity and identify key morphological and molecular characters used in plant classification.
CO4	Analyze various approaches to plant classification with a focus on data analysis and phylogenetic methods.
CO5	Evaluate major taxa and their identifying characteristics, and develop in-depth knowledge of the current taxonomy of a major plant family
CO6	Develop the diverse taxonomic resources, reference materials, herbarium collections, and publications

Course Content

Unit	Topic	No. of Lectures/ hours (45)
1	**Pteridophytes:** General characteristics, classification, early land plants (Rhynia); classification (up to family), morphology, anatomy, and reproduction of Selaginella, Equisetum, and Pteris; heterospory and seed habit, stellar evolution; ecological and economic importance of Pteridophytes.	10
2	**Gymnosperms:** General characteristics, classification (up to family), morphology, anatomy, and reproduction of Cycas, Pinus, and Ephedra; ecological and economic importance.	10
3	**Introduction to plant taxonomy:** Identification, classification, nomenclature, functions of herbarium, important herbaria and botanical gardens of the world and India Important flora, botanical nomenclature (principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, the principle of priority and its limitations). Classification: Types of classification-artificial, natural, and phylogenetic Bentham and Hooker (upto series) and Hutchinson classification.	10
4	**Taxonomy of plant families:** Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Asteraceae, Poaceae, and Orchidaceae (Families can be chosen as per the availability of local flora)	15

Suggested readings

- Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Pteridophyta, S Chand and Company Ltd., Ramnagar, New Delhi, India.
- 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.
- Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot,

Allahabad.

- Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
- 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.
- Parihar, N.S. (2013). Biology and Morphology of Pteridophytes. Central Book Depot.
- Sharma, O.P. (2006). Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
- Pandey, B.P. (2010). College Botany Vol II. S. Chand and Company Ltd., New Delhi, India.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	1	3	0	2	1	3	3	3	3	2	2
CO2	2	3	2	3	0	2	2	1	0	2	2	3	1	1	2	2
CO3	2	2	2	2	2	0	3	2	2	3	0	2	1	1	2	3
CO4	1	3	2	2	2	2	3	1	3	0	2	2	2	3	3	1
CO5	2	0	2	0	2	1	0	1	3	2	3	1	2	3	1	3
CO6	3	2	1	2	3	2	2	2	0	2	2	1	3	2	2	3

Practical/Lab Course
BOTDL202

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

CO1	Identify the group of plants that have given rise to land habit and the flowering plants.
CO2	Explain morphology, reproduction, and developmental changes therein through typological study.
CO3	Apply through field study they will be able to see these plants growing in nature and become familiar with the biodiversity.
CO4	Analyze by observation on representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
CO5	Reconstruct a knowledge base in Understanding the basis of plant diversity, economic values & taxonomy of plants.
CO6	Evaluate the use diverse taxonomic resources, reference materials, herbarium collections

Course Content

Unit	Topic	No. of Lectures/ hours (30)
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).	7
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).	8
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)	10
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.	5

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.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1	3	2	0	3	2	3	2	1	2	1	3
CO2	3	3	2	2	2	0	2	1	2	3	2	0	2	2	2	2
CO3	0	0	1	1	2	2	2	1	2	0	2	3.	2	2	3	0
CO4	3	3	0	2	0	3	1	2	2	3	2	2	0	3	2	2
CO5	3	3	2	2	3	2	0	2	3	3	0	2	3	2	3	2
CO6	2	2	3	0	2	2	2	3	0	3	2	2	2	0	1	3

Semester-III
Morphology and Anatomy
BOTDC301

Course Outcomes:

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

CO1	Define the terms associated with the morphology and anatomy of plants.
CO2	Identify the morphology and anatomy of plants and the role of tissues in plant functions.
CO3	Explain and write about Vascular cambium – structure and function, seasonal activity. Secondary growth, Epidermis, cuticle, stomata.
CO4	Analyze the vegetative characteristics of the plant, various tissue systems; the normal and anomalous secondary growth in plants.
CO5	Evaluate the composition, modifications, internal structure & architecture of plants.
CO6	Categorize morphological and anatomical characters of plants

Course Content

Unit	Topic	No. of Lectures/ hours (45)
1	**Meristematic and permanent tissues:** Types of tissues, Root and shoot apical meristems, Theories related to apical meristem, simple, complex and secretary 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. (2022). 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.
- Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	0	1	3	2	3	2	1	2	3	2	3	2
CO2	2	3	0	1	3	2	2	1	0	2	1	0	3	2	0	3
CO3	1	0	2	2	3	0	2	2.	2	3	2	2	3	3	3	2
CO4	2	3	1	3	2	2	2	1	2	3	2	2	2	0	2	0
CO5	3	2	2	0	2	2	2	3	2	2	0	2	2	3	2	3
CO6	3	2	3	2	2	2	2	3	2	2	1	2	2	1	2	3

Practical/Lab Course
BOTDL302

Course outcomes:

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

CO1	Define the terms associated with the morphology and anatomy of plants.
CO2	Develop cell structure in monocot and dicot plants.
CO3	Explain about vascular cambium – structure and function, seasonal activity. Secondary growth, Epidermis, cuticle, stomata
CO4	Analyze cell structure, secondary growth, and adaptive anatomy in plants
CO5	Evaluate the composition, modifications, internal structure & architecture of plants.
CO6	Construct and demonstrate live specimen of locally available the flora.

Course Content

Unit	Topic	No. of Lectures /hours (30)
1	Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma), complex and secretary tissues	6
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)	10
3	Adaptive anatomy: Xerophytes, Hydrophytes, Epiphytes (Plants can be chosen as per availability of local flora)	8
4	Normal and abnormal secondary growth in different plants (Plants can be chosen as per availability of local flora)	6

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.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	1	1	3	2	1	2	1	2	3	2	2	2
CO2	2	3	3	1	2	2	2	1	3	2	1	2	3	3	1	3
CO3	1	2	3	2	2	3	2	2	3	3	2	2	3	3	2	3
CO4	3	1	2	3	3	2	2	1	2	3	2	2	2	3	1	2
CO5	3	3	2	3	3	2	2	3	2	2	1	2	2	3	2	2
CO6	3	3	2	2	2	2	2	3	2	2	1	2	2	1	3	1

Semester-IV
Embryology and Cytogenetics
BOTDC401

Course Outcomes:

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

CO1	Define the terms associated with embryology and Cytogenetics
CO2	Explain the concept, structure, and developmental of embryology and Cytogenetics
CO3	Demonstrate the knowledge of embryology and cytogenetics.
CO4	Analyze and differentiate the term related to embryology and cytogenetics.
CO5	Summarize the process of embryology and cytogenetics.
CO6	Solve the problem associated with cytogenetics and embryology.

Course Content

Unit	Topic	No. of Lectures/ hours(45)
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
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

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. (1992). Embryology of Angiosperms. Springer-Verlag, Berlin
- Maheshwari, P. (2008). An Introduction to Embryology of Angiosperms. McGraw Hill Book Co. London.
- Rastogi, V.B. (2019). Genetics. 4th Edition. MEDTECH: A Division of Scientific International.
- Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
- Gupta, P.K. *Cytogenetics.* (2021) Rastogi Publications, India.
- D. L. Nelson and M. M. Cox, (2012). Lehninger Principles of Biochemistry, 6th Ed., Macmillan Worth,.
- H. Lodish, A. Berk, S. L. Zipursky, M. P. Scott and J. Darnell, (2021).Molecular Cell Biology, 9th Ed., W. H. Freeman & Co.,

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	1	2	1	1	1	2	0	2	3	3	3	2	2
CO2	3	3	2	0	3	2	2	1	3	2	2	3	1	1	2	2
CO3	2	2	2	2	2	2	0	2	2	3	1	2	1	1	2	3
CO4	1	3	2	2	0	3	2	0	3	2	2	2	2	0	3	1
CO5	2	3	2	3	2	3	3	1	0	2	0	1	2	3	2	3
CO6	3	2	1	2	3	2	2	2	3	2	2	1	3	2	2	3

Practical/Lab Course
BOTDL402

Course Outcomes:

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

CO1	Recognize the type and mechanism involve in Embryology and Cytogenetics.
CO2	Explain the laboratory exercises related to Embryology and Cytogenetics.
CO3	Demonstrate Mendel's principles and different process of embryology.
CO4	Analyze the process of chromosomal aberration and embryology.
CO5	Evaluate the problems of Mendel's laws, and its exceptions through seed ratios.
CO6	Compare the process related to Embryology and Cytogenetics.

Course content

Unit	Topic	No. of Lectures/ hours(30)
1	Pollination types and seed dispersal mechanisms (photographs and specimens)	4
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)	8
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 sex-linked traits. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).	12
4	Study of Euploidy and aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs. Photographs/permanent slides showing translocation ring, laggards, and inversion bridge	6

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

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	0	3	2	3	3	2	3	1	2	3	3	2	2	2
CO 2	1	2	1	0	1	2	3	0	2	2	3	1	0	3	0	1
CO 3	3	3	0	3	3	2	3	3	0	2	2	3	3	0	3	0
CO 4	2	1	3	2	0	2	3	3	0	2	2	0	3	3	3	3
CO 5	3	3	2	2	2	0	3	0	3	1	3	3	2	1	1	2
CO 6	3	1	2	2	3	2	1	3	1	1	0	2	2	2	1	0

Semester-V
Economic Botany and Plant Breeding
BOTDC501

Course Outcomes:

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

CO1	Define the concept and terminology of economic botany and plant breeding.
CO2	Explain the significance of plants and the methodology of plant breeding.
CO3	Illustrate methods of plant breeding and uses of economically important crops.
CO4	Analyze the economically useful plants.
CO5	Design the procedure involved in economic botany and plant breeding.
CO6	Evaluate the practical applications of economic botany and plant breeding.

Course Content

Unit	Topic	No. of Lectures /Hours (45)
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 Aloe 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; Centre of origin and domestication of crop plants, plant genetic resources; acclimatization; selection methods.	10
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

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	0	2	1	2	0	1	2	1	2	1	2	0	3
CO 2	3	1	0	2	2	3	1	3	2	0	2	0	2	3	2	2
CO 3	1	1	3	1	2	3	2	3	2	0	2	3	2	2	3	0
CO 4	2	3	3	2	0	0	2	0	2	3	2	2	3	3	2	2
CO 5	2	2	0	2	3	2	3	2	3	3	0	1	3	2	0	2
CO 6	2	3	3	2	2	2	2	3	0	3	2	2	2	1	1	0

Practical/Lab Course
BOTDL502

Course Outcomes:

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

CO1	Memorize the terms associated with economic botany and plant breeding
CO2	Explain the details of economically important crop plants.
CO3	Apply the different techniques for breeding programs.
CO4	Analyze the plants for economic use.
CO5	Evaluate the diversity of economically important plants.
CO6	Create a Germplasm for future use.

Course content

Unit	Topic	No. of Lectures/ Hours (30)
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	6
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	10
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.	4
4	Important varieties of crop plants for germplasm conversation. Hybridization techniques – Emasculation, Bagging, tagging and pollination (For demonstration only). Induction of polyploidy in plants (For demonstration only).	8

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	1	2.	1	2	1	3	2	1	2.	3	2	1	1
CO 2	3	1	3	2	2	3	2	3	2	1	2	3	2	3	2	3
CO 3	3	1	3	2	2	3	2	3	2	1	2	3.	2	2	3	3
CO 4	2	3	3	3	1	1	2	3	2	3	2	2	2	3	2	1
CO 5	3	2	3	3	3	2	3	2	3	3	1	2	3	2	3	2
CO 6	1	3	3	2	2	2	2	3	1	3	2	2	1	1	1	2

Semester-VI
Plant Physiology and Biochemistry
BOTDC601

Course Outcomes:

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

CO1	Describe the concept of Plant Physiology and Biochemistry.
CO2	Explain the knowledge of Plant Physiology and Biochemistry.
CO3	Illustrate the experiments based on Plant Physiology and Biochemistry.
CO4	Analyze and classify the knowledge about Plant Physiology and Biochemistry.
CO5	Develop the fundamentals and advanced aspects of Plant Physiology and Biochemistry.
CO6	Elaborate the knowledge of plant physiology and biochemistry.

Course Content

Unit	Topic	No. of Lectures /Hours (45)
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., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th 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.
- Frank B. Salisbury, Cleon W. Ross Plant Physiology. Wadsworth Publishing Company, 2009 - Nature

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	3	0	2	1	3	2	0	2	0	1	3	3	0	2
CO 2	2	3	2	2	3	2	1	2	0	3	3	3	2	2	2	0
CO 3	3	2	2	3	2	0	2	0	3	2	0	2	2	2	2	2
CO 4	3	3	2	2	0	1	2	2	2	0	2	0	3	2	0	0
CO 5	2	2	2	0	2	2	0	2	2	1	2	3	2	2	2	2
CO 6	3	2	3	3	2	2	2	3	2	1	2	0	2	3	3	2

Practical/Lab Course
BOTDL602

Course Outcomes:

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

CO1	Knows the knowledge experimental values of Plant physiology and Biochemistry
CO2	Generalized the Principles of Plant physiology and Biochemistry.
CO3	Illustrate the experiments related to Plant physiology and Biochemistry
CO4	Contrast and execute the experiment based on Plant physiology and Biochemistry
CO5	Perform the experiments related to Plant physiology and Biochemistry.
CO6	Solve the problem related to plant physiology and biochemistry.

Course Content

Unit	Topic	No. of Lectures /hours (30)
1	Demonstration of process of diffusion, osmosis, and plasmolysis. Demonstration of transpiration in dorsiventral leaf by four leaf and cobalt chloride method. Determination of rate of transpiration by Ganong's/Farm potometer. Demonstration of the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis by Wilmotts Bubler.	8
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	6
3	Test of carbohydrates, proteins, and fats.	6
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	4

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	1	2.	0	2	1	0	2	1	0	3	2	0	1
CO 2	3	0	3	2	2	3	2	3	2	0	2	3	2	3	2	0
CO 3	3	1	3	2	2	3	2	0	2	0	2	2	2	2	0	3
CO 4	2	3	3	0	0	1	2	3	2	3	2	2	2	3	2	1
CO 5	3	2	0	3	3	2	0	2	3	3	1	2	3	2	2	2
CO 6	1	3	3	2	2	2	2	3	0	3	2	2	1	1	1	2

Semester-VII
Plant Pathology and Plant Health Management
BOTDC 701

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

CO1	Define the terms associated with plant pathology and plant health management
CO2	Explain the concepts of plant pathology and learn defense mechanism in plants
CO3	Illustrate the important of plant diseases with reference to Nursery and cash crops.
CO4	Differentiate the important diseases of Plantation crops.
CO5	Summarized the various types of mycorrhizal associations and their role in forestry.
CO6	Write the diseases of cereals, millets, vegetables and fruit trees.

Course content

Unit	Topic	No. of lectures/hours (45)
1	Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host- Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.	10
2	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
3	Nursery disease: Important disease of nursery plants. Plantation disease: Plantation disease of Chir pine, Eucalyptus, Sal, Teak, Shisam, Populus, Acacia (Catechu).	10
4	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, Diseases of cereals, millets, vegetables and fruit trees	15

Suggested Readings

- Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
- Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
- Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	2	1	3	2	1	1	3	2	3	2
CO2	2	3	2	2	0	2	2	2	3	2	0	3	2	2	2	2
CO3	3	2	2	0	2	2	0	2	0	1	3	2	2	0	2	0
CO4	2	2	2	2	2	2	1	3	2	0	2	2	3	2	1	2
CO5	2	3	2	1	1	0	2	0	2	1	2	3	2	2	2	1
CO6	3	3	2	3	1	2	2	2	2	3	2	0	2	3	0	3

Practical/Lab Course
BOTDL702

Course Outcome:

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

CO1	Define the basic terminology and fundamental concept of Plant Diseases.
CO2	Explain Symptoms, causes, etiology of the pathogen through diseased specimen
CO3	Apply seed soak method for the detection of seed borne pathogen
CO4	Analyze and Isolate some important plant pathogen.
CO5	Evaluate the growth of pathogen through agar plate technique
CO6	Write Plant Disease Clinic for Management or control

Course content

Unit	Topic	No. of Lectures/ Hours (30)
1	Study of seed borne pathogen. Description of pathogen, symptoms and section cutting	8
2	Isolation of some important pathogens. Procedure of equipment uses.	8
3	To establish a plant disease clinic in the department for advise to local people.	4
4	Diseases of crops, plantation crops, fruit trees through specimens	10

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.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	0	2	2	2	2	1	0	2	1	1	3	2	3	0
CO2	2	1	2	2	1	2	2	2	3	2	0	3	2	2	2	3
CO3	3	2	2	0	2	2	0	2	0	1	3	2	2	0	2	0
CO4	2	2	2	2	2	2	1	0	2	0	2	2	3	2	1	2
CO5	2	3	2	1	1	0	2	0	2	1	2	3	2	2	2	2
CO6	3	3	2	1	1	2	2	2	2	0	2	0	2	3	3	2

Semester-VIII

Ecology and Biostatistics
BOTDC801

Course outcome

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

CO1	Define terminology of ecosystem and biostatistical methods.
CO2	Explain different factors and methods involved in ecosystem and biostatics.
CO3	Apply different statistics tools to solve problems in ecology.
CO4	Analyze plant diversity with the help of biostatistical tools.
CO5	Evaluate strategies for sustainable natural resource management and biodiversity conservation.
CO6	Summarize abiotic and biotic factors and their graphical representations.

Course Content

Unit	Topic	No. of Lectures/ hours (45)
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.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	2	0	2	1	1	3	2	2	2.	1	2	1	0
CO2	3	1	2	2	2	1	2	3	2	1	2	3	2	3	2	2
CO3	3	1	0	2	2	3	2	2	2	0	2	0	2	2	0	0
CO4	3	3	3	2	1	2	0	2	2	3	2	2	3	3	2	2
CO5	2	2	2	0	3	2	3	2	0	3	1	2	3	2	3	2
CO6	2	3	3	2	2	2	2	0	1	3	2	2	2	1	1	3

Practical/Lab Course
BOTDL802

Course Outcomes:

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

CO1	Memorize the terms and instruments used ecology and bio stats.
CO2	Explain the structure and function of different ecosystems and their components.
CO3	Apply practical knowledge of biostatistics implemented in the biodiversity assessment and Conservation.
CO4	Analysis of soil samples and statistical methods to analyze biological data.
CO5	Evaluate morphological adaptations of plants in various ecosystem.
CO6	Develop problem-solving skills through ecological and statistical case studies.

Course content:

Unit	Topic	No. of Lectures/ hours (30)
1	Observation and study of different ecosystems mentioned in the syllabus. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, rain gauge and lux meter. Determination of Ph, and analysis of soil samples for soil moisture, 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.	20
2	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. and comment upon it.	10

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.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	0	2	1	1	3	2	2	2.	1	2	1	1
CO2	3	1	2	2	2	1	2	0	2	1	2	3	2	3	2	0
CO3	3	1	2	2	2	3	2	2	2	0	2	0	2	2	0	3
CO4	3	3	0	2	1	2	1	2	2	3	2	2	0	3	2	2
CO5	3	2	2	2	3	2	3	2	3	3	0	2	3	2	3	3
CO6	3	3	3	2	2	2	2	3	1	3	2	2	2	1	1	2

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

Course outcomes:

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

CO 1	Recall the Imaging the Analytical Techniques in Plant Sciences.
CO 2	Explain the use of instrument and Analytical Techniques in Plant Sciences.
CO 3	Apply and Understand principles of Analytical Techniques in Plant Sciences.
CO4	Analyze the applications of Analytical Techniques in Plant Sciences.
CO5	Summarized the principles of different Analytical Techniques in Plant Sciences.
CO6	Develop the knowledge about Analytical Techniques in Plant Sciences.

Course Content

Unit	Topic	No. of Lectures /Hours (30)
1	**Imaging and related techniques**: Principles of microscopy; Light microscopy; Fluorescence microscopy; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryo-fixation, negative staining	9
2	**Cell fractionation Centrifugation**: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient and ultracentrifugation	9
3	**Blotting techniques:** Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR and ELISA.	4
4	Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography, spectrometry; X-ray diffraction; 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

- Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A
- S.D. Ramteke and J.H. Meshram. (2019). Plant Analytical Techniques, p236, Daya Publication House, New Delhi
- P.K. Banerjee. (2012). Biostatistics. S. Chand Publ., New Delhi.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Karp, G. (2020). Cell and Molecular Biology: Concepts and Experiments. 9th Edition. John Wiley and Sons. Inc.
- Bruce Alberts, Alexander Johnson, Julian Lewis (2022). Molecular Biology of the Cell. 9 th edition Garland

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	3	2	1	2	1	2	0	3	1	3	2
CO2	3	2	0	3	0	2	2	1	3	2	2	3	1	1	2	2
CO3	2	2	2	2	2	0	3	2	2	2	0	2	1	1	2	3
CO4	1	3	2	2	2	3	2	1	3	2	2	2	2	3	1	1
CO5	2	0	2	0	2	2	0	1	3	2	3	1	2	3	2	3
CO6	3	2	1	2	3	2	2	2	0	2	2	1	3	2	2	0

Practical/Lab Course
Analytical Techniques in Plant Sciences
BOTDL304

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

CO1	Recall the Imaging the Analytical Techniques in Plant Sciences.
CO2	Explain the use of instrument and Analytical Techniques in Plant Sciences.
CO3	Apply principles of Analytical Techniques in Plant Sciences.
CO4	Analyze the applications of Analytical Techniques in Plant Sciences.
CO5	Summarized the principles of different Analytical Techniques in Plant Sciences.
CO6	Develop the knowledge about Analytical Techniques in Plant Sciences.

Course Content

Unit	Topic	Lectures/ Hours (30)
1	Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs. Demonstration of ELISA.	4
2	Isolation of chloroplasts by differential centrifugation. To separate chloroplast pigments by column chromatography and paper chromatography	8
3	To estimate protein concentration. To separate proteins using PAGE	4
4	To separate DNA using AGE	6
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).	8

Suggested Readings

- Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
- 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.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Karp, G. (2020). Cell and Molecular Biology: Concepts and Experiments. 9th Edition. John Wiley and Sons. Inc.
- Bruce Alberts, Alexander Johnson, Julian Lewis (2022). Molecular Biology of the Cell. 9 th edition Garland

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2	3	2	2	2	2	0	2	1	2	3	0	3
CO2	3	2	2	0	1	3	2	1	0	2	2	2	3	1	2	0
CO3	2	1	2	2	1	0	3	1	2	0	1	1	3	1	2	2
CO4	2	3	2	2	2	2	2	3	3	2	2	2	1	3	1	2
CO5	2	2	2	0	2	3	0	1	0	2	1	2	3	3	2	1
CO6	3	2	0	2	3	2	2	2	0	2	2	1	2	2	2	1

Semester-IV
Introduction to Medicinal and Aromatic Plants
BOTDE403

Course Outcomes:

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

CO1	Define and describe terminology, concept, status and future prospect of medicinal and aromatic plants.
CO2	Explain the plant diversity of India and its promotion in relation to Medicinal and Aromatic Plants.
CO3	Identify the issues and approaches to conserve the medicinally important herbs
CO4	Analyze Medicinal and aromatic plants used in different industries
CO5	Evaluate and justify the role of agencies constituted for promotion of medicinal and aromatic plant sector at national level.
CO6	Categorize the benefits of Medicinal and Aromatic Plants.

Course content:

Unit	Topic	Lecture/hours (60)
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, Belladona 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

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

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	3	3	2	1	2	0	2	3	2	1	1	3	2	0
CO2	1	2	2	2	0	2	2	2	3	2	0	3	2	2	3	2
CO3	3	2	2	3	2	2	3	2	0	1	3	2	2	2	0	0
CO4	3	3	2	2	2	0	0	3	2	0	2	3	3	1	2	2
CO5	1	2	2	1	1	3	2	3	2	1	1	2	2	2	3	0
CO6	2	2	2	0	1	2	2	2	0	3	1	0	2	3	1	2

Practical/Lab Course
BOTDL404

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

CO1	List medicinal and aromatic plants of India with reference to Uttarakhand.
CO2	Explain the methods used to extract phyto-constituents of medicinal and aromatic plants.
CO3	Apply the knowledge of cultivation practices for growing medicinal and aromatic plants.
CO4	Analyze the antimicrobial activities of medicinal and aromatic plants.
CO5	Evaluate the medicinal potential of the plant based on the phytochemical profile.
CO6	Create an optimized cultivation plan for medicinal and aromatic plants

Course Content

S.N	Experiment	No. of Lectures/ Hours (30)
1	Extraction of Essential Oils from Lavender, Peppermint or locally available plants	6
2	Study of medicinal and aromatic plants of India with special reference to Uttarakhand (Botanical name, common name, and uses)	6
3	Phytochemical screening of medicinal plants viz., Neem, Tulsi	6
4	Antimicrobial activity of Medicinal plants	6
5	Study the growth and cultivation practices of medicinal and aromatic plants	6

Suggested Readings

- Harborne, J.B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. Chapman & Hall.
- C.P. Kala (2010). Medicinal Plants of Uttara khand.
- P.C. Trivedi (2009). Indian Medicinal Plants, Pointer Publ. Jaipur
- S.K. Bhattacharjee (2009).Handbook of MAPs.
- E. K. Sharma & A. K. Sharma. (2018). Textbook of Medicinal and Aromatic Plants. International Book Distributors, Dehradun
- V. V. Sivarajan. Handbook of Medicinal and Aromatic Plants. Oxford & IBH

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	1	2	3	2	2	2	0	1	3	2	1
CO2	2	2	2	2	1	2	2	2	1	1	0	3	2	2	3	2
CO3	2	2	2	0	2	2	0	2	0	2	3	2	2	2	3	3
CO4	2	0	2	2	2	0	1	0	2	2	2	3	3	3	2	2
CO5	2	3	2	1	1	3	2	0	2	1	1	2	2	2	3	1
CO6	2	2	2	3	1	2	2	2	0	1	1	0	2	3	1	2

Semester-V
Cell and Molecular Biology & Plant Biotechnology
BOTDE503

Course outcomes:

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

CO1	Define the terminology and concept of Cell and Molecular Biology & Plant Biotechnology.
CO2	Illustrate the structure, and functions of Cell and Molecular Biology & Plant Biotechnology.
CO3	Explain the basic principles of cell and molecular biology, basic techniques of Recombinant DNA Technology
CO4	Analyze the process of cell, molecular biology and Plant Biotechnology.
CO5	Compare and discuss about basic concepts of cell, molecular biology and plant biotechnology.
CO6	Assess the techniques used in cell, molecular biology and plant biotechnology.

Course content

Unit	Topic	No. of Lectures/ hours (45)
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
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

Suggested readings

- 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.
- 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.
- Karp, G. (2020). Cell and Molecular Biology: Concepts and Experiments. 9th Edition. John Wiley and Sons. Inc.
- Bruce Alberts, Alexander Johnson, Julian Lewis (2022). Molecular Biology of the Cell. 9 th edition Garland Science / Taylor & Francis

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	1	1	0	2	1	2	3	3	3	2	2
CO2	3	3	2	3	0	2	2	1	0	2	2	0	1	1	2	2
CO3	2	2	2	2	2	3	0	2	2	0	1	2	1	1	2	3
CO4	1	3	2	2	2	0	1	1	3	2	2	2	2	3	0	1
CO5	2	3	2	0	2	2	3	1	3	2	0	1	2	3	2	0
CO6	3	2	1	2	3	2	2	2	0	2	2	1	3	2	2	2

Discipline-Specific Elective
Semester-V
Practical/Lab Course BOTDL504

Course outcomes

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

CO1	Describe various cell organelles through slides and photographs.
CO2	Gain knowedelge of Instruments and equipment used in cell, molecular biology and recombinant DNA technology.
CO3	Identify and familiarize with basic equipment in tissue culture.
CO4	Illustrate the structure of cell and categorize the methods used in molecular biology and plant biotechnology.
CO5	Measure the cell, its organelles and techniques used in molecular biology and plant biotechnology.
CO6	Compare the different processes of plant tissue culture and recombinant DNA technology used in plant biotechnology.

Course content

Unit	Topic	No. of Lectures/ Hours (30)
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.	10
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.	10
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	10

Suggested readings

- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- H. S. Chawla, Text book of Biotechnology. Oxford & IBH Publ., House
- Karp, G. (2020). Cell and Molecular Biology: Concepts and Experiments.8th Edition. John Wiley and Sons. Inc.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	1	1	1	2	1	2	3	3	3	2	3
CO2	3	3	2	0	0	2	2	1	3	2	2	3	1	1	2	0
CO3	2	2	2	2	2	0	3	2	2	0	0	2	1	1	2	1
CO4	1	0	2	2	2	1	0	1	0	2	2	2	2	3	2	2
CO5	2	3	2	3	2	2	0	1	0	2	3	0	2	3	2	0
CO6	3	2	1	2	3	2	2	2	3	2	2	1	3	2	2	2

Semester-VI
Palynology and Pollination Biology
BOTDE603

Course Outcomes:

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

CO1	Describe the general concepts of palynology and pollination biology.
CO2	Explain the structure and development of pollen.
CO3	Examine the morphological features of pollen.
CO4	Analyze and identify the various aspects of Palyno-taxonomy and pollination biology.
CO5	Comply the importance of palynology and pollination biology.
CO6	Generalized the concepts Palynology and Pollination Biology.

Course Content

Unit	Topic	No. of lectures/hours (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:** AeroalIergens, 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

- Erdtman, G. 1952. Pollen morphology and Plant Taxonomy, Angiosperm: Almquist and Wiksell, Stockholm.
- Bhattacharya, K. and Majumdar, M.R. 2011. A text book of Palynology. P364. New Central Book Agency.
- Nair, P.K.K. 1966. Essentails of Palynology; Asia Publication House Lucknow.
- Woodhouse, R.P. 1965. Pollen Grains: Hafner Publication Co.
- Dharam P. Abrol (2012). Pollination Biology: Biodiversity Conservation and Agricultural Production. 1st Edition. Springer

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	1	2	2	2	0	1	2	0	2	0	3	3	2	2
CO 2	3	1	2	2	0	2	2	0	0	2	2	3	1	1	2	2
CO 3	2	2	2	2	2	3	3	2	2	3	1	2	1	1	2	3
CO 4	1	0	2	2	2	0	2	1	0	2	2	2	2	3	1	1
CO 5	2	3	2	0	2	1	3	1	3	2	2	1	2	0	2	3
CO 6	3	2	0	2	0	2	2	2	1	2	2	1	0	2	2	3

Practical/Lab
Course BOTDL604

Course Outcomes:

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

CO1	Examine the pollen grains from plants samples and to study the frequency of different morphotypes.
CO2	Distinguish the in vivo and in vitro germination of pollen grains.
CO3	Apply knowledge to study allergy producing pollen Morpho-types.
CO4	Analyze Morpho-anatomical study of stigma and style.
CO5	Evaluate pollen viability of angiosperms
CO6	Solve the problem related to palynology and pollen morphology

Course Content

Unit	Topic	No. of lectures/ hour (30)
1	Pollen morphological studies of some Pteridophyte, gymnosperms, and angiosperms representing different morphological types using acetolysis / alkali maceration method.	18
2	Study of in vivo and in vitro germination of pollen grains.	6
3	Study of allergy producing pollen morpho-types.	4
4	Determination of pollen viability	2

Suggested Readings

- Erdtman, G. 1952. Pollen morphology and Plant Taxonomy, Angiosperm: Almquist and Wiksell, Stockholm.
- Bhattacharya, K. and Majumdar, M.R. 2011. A text book of Palynology. P364. New Central Book Agency.
- Nair, P.K.K. 1966. Essentails of Palynology; Asia Publication House Lucknow.
- Woodhouse, R.P. 1965. Pollen Grains: Hafner Publication Co.
- Dharam P. Abrol (2012). Pollination Biology: Biodiversity Conservation and Agricultural Production. 1st Edition. Springer

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	1	0	3	2	1	2	0	2	3	2	2	2
CO2	2	3	3	1	2	2	2	0	3	2	1	2	3	0	1	3
CO3	1	2	0	2	2	3	2	2	0	0	2	2	3	3	2	3
CO4	3	1	2	3	3	2	2	1	2	3	2	2	2	3	1	2
CO5	3	3	2	3	3	2	2	3	2	2	0	2	2	0	2	2
CO6	3	3	2	2	2	2	2	3	2	2	1	2	2	1	3	1

SEMESTER-VII
Plant Resource Utilization and Conservation
BOTDE703

Course outcomes:

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

CO1	Define the concepts of Plant resources its economic value and conservation
CO2	Explain economically important plants and conservation.
CO3	Identify the economically important plants of Uttarakhand and its conservation.
CO4	Analyze initiatives and measures for biodiversity conservation.
CO5	Evaluate the Plant Resource Utilization and Conservation
CO6	Create germplasm storage for the conservation of economically important crops.

Course Content

Unit	Topic	No. of lectures/ hours (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
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

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).
- C.K. Kokate (2015). Principles and Practices of Plant Resource Utilization. Nirali Prakashan

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	0	1	3	2	1	2	3	2	3	2
CO2	2	3	2	2	0	2	2	2	0	2	0	3	2	2	2	3
CO3	3	1	2	3	2	2	3	2	3	1	3	2	2	2	2	0
CO4	3	3	2	2	2	0	1	3	2	0	2	2	3	2	0	1
CO5	2	1	2	0	1	3	2	0	2	1	2	3	2	2	2	0
CO6	3	3	0	3	0	2	2	2	1	3	2	0	2	2	1	2

Practical/Lab Course
BOTDL704

Course outcomes:

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

CO1	Outline the knowledge of different plant resources and its utilization
CO2	Explain morphology, anatomy and uses of different crop plants
CO3	Apply micro-chemical test for the detection stored food materials.
CO4	Analyze economically plant parts using microscopic study.
CO5	Evaluate the excursion/ field report
CO6	Write strategies for conservation of biodiversity.

Course Content

Unit	Topic	No. of lecturers/hours (30)
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.	6
2	ii. Forage/fodder plants: Study of ten important fodder crops of the locality.	4
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.	6
4	Vegetable oils: Mustard, groundnut, soybean, coconut, sunflower and castor. Morphology, microscopic structure of oil yielding tissues, test for oil, Iodine value	4
5	Scientific visits, Field trips, compilation of field notes, the preparation herbarium sheets and submission of herbarium and museum specimens potted specimens of taxonomic interest and submission of the excursion report.	10

Suggested Readings

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

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	0	1	2	1	3	2	1	2.	3	2	1	1
CO2	3	1	0	2	2	3	2	0	2	0	2	3	2	3	2	0
CO3	3	1	3	2	2	3	2	3	2	1	2	0	2	2	3	3
CO4	2	3	0	3	1	0	2	3	2	3	2	2	2	3	2	2
CO5	3	2	3	0	3	2	0	2	0	3	1	2	3	2	3	1
CO6	1	3	3	2	2	2	2	0	1	0	2	2	1	1	1	0

Microbiology BOTDE705

Course outcomes:

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

CO1	Outline the knowledge about the history, concept and scope of Microbiology.
CO2	Explain the general account of microbiology.
CO3	Apply practical skills in basic microbiological techniques.
CO4	Analyze the characteristics, mode of reproduction and economic importance of microbes.
CO5	Evaluate the classificatory approaches and advances in microbiology
CO6	Summarize the knowledge about the Microbiology

Course Content

Unit	Topic	No. of lectures/hours (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, fimbrae, 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

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.
- Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2	2	3	0	1	2	1	2	3	3	3	2	2
CO2	3	0	2	0	3	2	2	0	3	2	2	0	1	1	2	0
CO3	2	2	2	2	2	0	3	2	2	0	0	2	1	1	2	2
CO4	0	1	2	2	2	3	2	1	0	2	2	2	2	0	0	2
CO5	2	3	2	3	2	1	3	1	3	2	2	1	2	3	2	2
CO6	3	2	0	2	0	2	2	2	0	2	2	0	0	2	2	0

Practical/Lab Course
BOTDL706

Course Outcome:

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

CO1	Describe the knowledge of different groups of microbes.
CO2	Explain about different instruments and lab safety rules
CO3	Illustrate the methods of isolation and identification
CO4	Analyze the agar plate technique for isolation, enumeration and identification of microbes
CO5	Summarize the identification and Isolation of bacteria
CO6	Write the knowledge of media preparation

Course content

Unit	Topic	No. of lectures/hours (30)
1	Aseptic methods and demonstration of instruments viz., autoclave, hot air oven, incubator, laminar-airflow.	6
2	Isolation and enumeration of microbes from natural samples (soil and water) by agar plate technique	6
3	Direct examination of root nodule bacteria under microscope and isolation of Rhizobium in root nodules	8
4	Symptomology and diseased specimens of plants caused by bacteria and viruses	10

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.
- Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2	2	0	2	1	2	1	2	3	3	3	2	2
CO2	3	0	2	3	0	2	2	0	3	2	2	0	1	1	2	0
CO3	2	2	2	2	2	3	0	2	2	0	1	2	1	1	2	2
CO4	1	0	2	2	2	3	2	1	0	2	2	2	2	3	1	0
CO5	2	3	2	0	2	1	0	1	3	2	0	1	2	3	2	2
CO6	3	2	0	2	0	2	2	2	0	2	2	1	3	2	2	1

Taxonomy and Diversity of Flowering Plants
BOTDE707

Course Outcome:

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

CO1	Define the terminology and memorize the concept of taxonomy and diversity of flowering plants.
CO2	Explain about the diversity, nomenclature and classification of plants
CO3	Apply the salient features of ICBN/ICN, species concept and taxonomic hierarchy
CO4	Analyze the Plant diversity in India with reference to Uttarakhand
CO5	Summarized taxonomic families from locally available flora using Semi-technical language
CO6	Write digital herbarium for the identification and documentation through inventory and field observations

Course Content

Unit	Topic	No. of lectures/hours (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
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

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 Linnaean 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.
- Judd, W.S., Campbell. (2016). 4 edition. Sinauer Associates (Oxford University Press)

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	1	0	3	2	3	2	0	2	3	2	2	1
CO2	3	0	1	2	0	2	2	1	0	2	1	2	3	1	0	2
CO3	3	2	2	2	3	3	2	2.	2	3	2	2	3	2	3	2
CO4	3	3	1	0	2	2	2	2	2	0	2	2	2	0	2	0
CO5	3	2	2	3	2	2	0	3	2	2	1	2	2	2	2	3
CO6	3	2	0	2	2	2	2	0	2	2	0	2	2	1	2	0

Practical/Lab Course
BOTDL708

Course Outcome:

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

CO1	Outline the basic terminology of taxonomy
CO2	Explain different genera belong to different classes of Angiosperms
CO3	Apply the methods of identification with the help of keys and flora
CO4	Analyze the herbarium for documentation and conservation
CO5	Summarize the diversity of locally available flora
CO6	Plan a 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

Course Content

Unit	Topic	No. of lectures/hours (30)
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.	6
2	Description of a species based on various specimens to study intraspecific variation.	4
3	Studies to find out the location of key characters and preparation of keys at generic level.	8
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.	12

Suggested Readings

- Rajan Sundara, S. (2021). Practical Manual of Angiosperm Taxonomy. Anmol Publication Pvt. Ltd.
- B.P. Pandey. (2019). Practical Botany-Revised ed. S. Chand Co. Ltd. Delhi
- Yadav, S. (2022). Plant Systematics with Practical. Mahaveer Publication.
- Judd, W.S., Campbell. (2016). 4 edition. Sinauer Associates (Oxford University Press)

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	1	1	0	2	0	2	0	2	3	2	2	2
CO2	3	3	0	2	0	2	2	1	3	2	1	2	3	1	3	3
CO3	2	2	2	2	3	3	2	0	2	3	2	2	3	2	0	0
CO4	1	1	1	0	2	2	2	2	2	0	2	2	2	3	2	2
CO5	3	2	2	3	2	0	2	3	2	2	1	2	2	2	2	3
CO6	3	2	0	2	2	2	2	3	2	2	1	2	2	1	2	0

Seed Technology
BOTDE709

Course Outcomes:

CO1	Define the term associated with seed technology, history, concept and importance.
CO2	Comprehend 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 though seeds.
CO3	Demonstration about the penetration of pathogens into seeds and factors that cause pathogens to live in seeds.
CO4	Differentiate the spread of seed-borne pathogens.
CO5	Describe to detect pathogens carried by seeds and seed health.
CO6	Write comprehensively about pathogens carried by fungi and bacteria.

Course Content

Unit	Topic	No. of Lectures/ Hours(45)
1	**Introduction,** terminology and historical development, seed health and its Importance. Structure and types of Dicot and monocot seeds. **Kinds of seed borne pathogens:** fungi, bacteria, viruses, viroides and Nematodes. **Types of damage** caused by the seed borne fungi to seeds and crops	10
2	**Nature of seed infection.** Systemic infection through flower, fruit and seed Stock. Penetration through seed coat, natural openings and inflicted Openings. **Longevity of seed borne pathogens.** Factors influencing longevity.	8
3	**Epiphytology** of seed borne diseases, monocyclic and polycyclic diseases. **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.	10
4	**Study of seed borne diseases** of certain specific crops, cereals, millets, pulses, oil crops, fibre crops, and vegetable and timber crops. **Control of seed borne pathogens**: selection of seed production areas, crop management, seed treatment, certification, plant quarantine and disease Resistance. Morphology of crop and seed for identification of varieties of following crops- Potato, Onion, Jowar, Wheat, Soybean & Sugarcane. (Any two locally cultivated varieties)	12

Suggested Readings

- Neegard P. 1977. Seed Pathology Vol I and II. MacMillan Press, London
- Suryanarayan, D. 1978. Seed Pathology. Vikas Publ. House. Pvt. Ltd. New Delhi.
- Jha, D.K. 1995. A Text Book of Seed Pathology. Vikas Publ. House. Pvt. Ltd. New Delhi.
- Agarwal, V.K. 1978. Principles of Seed Pathology. In (ed.) James B.S. Sindair.CRC Press. II Edition.
- Desai, B.B. Seed Handbook. CRC Press.
- Singh, Gurnam, Seed Pathology. Pointer Publisher, Jaipur.
- Singh, T. Seed Technology and Seed Pathology. Pointer Publisher, Jaipur.
- Nene, Y.L. and Agarwal, V.K. 1978. Some seed borne diseases and their control. ICAR, New Delhi
- George N. Agrios. (2005). 5th Edition. Plant Pathology

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	1	3	2	3	3	2	3	0	3	3	3	2	2	2
CO 2	3	0	2	0	1	3	1	0	2	3	0	1	2	1	0	0
CO 3	3	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	1	2	3	0	3	3	0	2	2	3	3	0	0	3
CO 5	3	3	2	0	2	2	0	3	3	3	3	0	3	1	2	1
CO 6	3	1	0	2	0	1	1	3	1	0	2	2	2	2	1	1

Practical/Lab Course BOTDL710

Course Outcomes

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

CO1	Discuss the techniques used for the detection of seed borne pathogens.
CO2	Explain the process of PCR, ELISA and other techniques.
CO3	Apply the seed soaking and seed washing test for the isolation of Seed borne fungi and bacteria.
CO4	Analyze the reduction of fungi by chemical treatment.
CO5	Evaluate the detection of fungi and bacteria by agar plate technique.
CO6	Assess symptomology test for the detection of seed borne diseases

Course Content

Unit	Topic	No. of Lectures/ Hours (30)
1	Field inspection of seed crops and visual examination of seeds for infections.	6
2	Seed soaking method for the detection of certain seed borne pathogens (fungi)	6
3	Seed washing tests and incubation methods, Seedlings symptomatology tests.	4
4	Detection of fungi and bacteria by Agar Plate methods	4
5	Visit to Seed testing laboratories, Certifying agencies and NBPGR	6
6	Demonstration of ELISA and PCR	4

Suggested Reading

- Singh, Gurnam, Seed Pathology. Pointer Publisher, Jaipur.
- Nene, Y.L. and Agarwal, V.K. 1978. Some seed borne diseases and their control. ICAR, New Delhi.
- Jha, D.K. 1995. A Text Book of Seed Pathology. Vikas Publ. House. Pvt. Ltd. New Delhi.
- George N. Agrios. (2005). 5th Edition. Plant Pathology

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	3	2	2	1	1	1	2	1	2	3	3	3	2	2
CO 2	3	0	2	0	3	2	2	0	3	2	2	0	1	1	2	2
CO 3	2	2	2	2	2	2	3	2	2	0	1	2	1	1	2	0
CO 4	1	3	2	2	2	0	2	0	0	2	2	2	2	0	3	1
CO 5	2	3	2	0	2	3	0	1	3	2	0	1	2	3	0	3
CO 6	3	2	0	2	3	2	2	2	0	2	2	1	3	2	2	0

Research Methodology (For Honours with research)
BOTDE711

Course outcomes:

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

CO1	Discuss various kind of research, objectives of doing research, research process and research design.
CO2	Explain the ability to choose methods appropriate to research aims and objectives.
CO3	Apply skills to analyse data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
CO4	Analyse statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
CO5	Evaluating the properties of mechanism of research methodology.
CO6	Write the research methodology for report writing.

Course Content

Unit	Topic	No. of lectures/hours (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
3	**Interpretation and Report Writing** 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	10
4	**Statistical Techniques and Tools -I** Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution. **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)	13

Suggested readings:

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

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	1	1	2	2	0	2	1	2	3	2	1	2
CO2	2	1	0	3	3	2	2	0	3	2	0	2	3	3	0	2
CO3	1	2	2	2	0	0	2	2.	2	3	2	2	3	2	3	2
CO4	3	0	1	3	2	2	0	3	2	0	2	2	2	0	2	2
CO5	3	2	2	0	2	2	2	3	2	2	1	0	2	2	2	0
CO6	3	2	3	2	2	2	2	0	2	2	1	2	2	1	2	2

Discipline Specific Elective
SEMESTER-VIII
Mycology
BOTDE801

Course Outcomes:

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

CO1	Define the knowledge about the history, concept and scope of mycology.
CO2	Explain the general characters, structure, nutrition, reproduction and the principles on Classifications of Fungi.
CO3	Illustrate the knowledge about the symptoms and causal organisms of various fungal diseases of plants.
CO4	Analyze the economic and pathological importance of fungi.
CO5	Categorise the occurrence, general characters, types, reproduction and life Cycles of the major fungal groups.
CO6	Construct the life cycle of different members of the Sub division Asco, Basdio, Zygo and Deuteromycotina

Course Content

Unit	Topic	No. of lectures/ Hours (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
4	**Ascomycotina:** Saccharomyces, Aspergillus, Talaromyces (Penicillium), Taphrina, Phyllactinia, Peziza, Cordiceps, Claviceps. **Basidiomycotina:** Puccinia, Ustilago, Geastrum, Fomes, Uromyces. **Deuteromycotina:** Fusarium, Cercospora, Pyricularia, Colletotrichum, Trichoderma, Helminthosporium	15

Suggested readings

- Ainsworth, G.C. (1977). Introduction to the history of Mycology. Cambridge University Press, Cambridge, London, New York, Melbourne
- Alexopoulas, C.J. and Mims C.W. (1995). Introductory Mycology. John Wiley and Sons. New York. Fourth Edition.
- Bryce Kendrick. (2017). The Fifth Kingdom: An Introduction to Mycology. Hackett Publishing. 4th Edition.
- John Webster and Roland Weber. (2007). Introduction to Fungi. Cambridge University Press. 3rd Edition.
- Kavanagh, Kevin. (2018). Fungi: Biology and Applications. Wiley-Blackwell. 3rd edition.
- Mehrotra, R.S. and K.R. Aneja. (1999). An Introduction to Mycology. New Age International Publisher.
- Sati, S.C. and Belwal, M. (2012). Microbes Diversity and Biotechnology. Daya Publication.
- Webster, J. (1985). Introduction to Fungi. Cambridge University Press. New York.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	1	2	2	0	1	1	0	1	2	2	3	3	1	2
CO 2	2	0	2	0	3	2	2	0	3	2	2	0	1	1	2	2
CO 3	3	2	2	2	2	0	3	2	2	0	1	2	1	1.	2	3
CO 4	3	3	2	2	2	2	0	1	0	2	2	2	2	0	0	1
CO 5	1	3	2	3	2	2	3	0	3	2	0	1	2	3	2	0
CO 6	2	2	0	2	0	2	2	2	3	2	2	0	3	2	2	1

Practical/Lab Course
BOTDL802

Course Outcomes:

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

CO1	Outline the knowledge of different genera belong to different classes of fungi.
CO2	Discuss about different instruments and lab safety rules.
CO3	Illustrate the methods of isolation and identification
CO4	Analyze the agar plate technique for isolation, enumeration and identification.
CO5	Reframe the identification and Isolation of fungi.
CO6	Develop the knowledge of media preparation.

Course Content

Unit	Topic	Lectures/ hours (30)
1	Study of representative genera of Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.	8
2	Symptomatology of at least one diseased specimen of plant pathogens belonging to various fungal sub-division i.e. Mastigomycotina, Zygomycotina, acomycotina, basidiomycotina and deuteromycotina	8
3	Aseptic methods and demonstration of instruments viz., autoclave, hot air oven, incubator, and laminar-airflow.	4
4	Isolation and enumeration of microbes from natural samples (soil and water) by agar plate technique	10

Suggested Readings

- B.P. Pandey. (2019). Practical Botany-Revised ed. S. Chand Co. Ltd. Delhi Semester-VIII

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	1	3	2	1	2	2	0	3	2	3	3	2	2	2
CO 2	3	2	1	0	0	2	0	1	2	2	0	1	3	2	2	0
CO 3	2	1	3	3	3	2	3	0	3	2	2	3	3	3	2	3
CO 4	1	3	0	2	3	2	0	3	3	2	2	3	3	0	1	0
CO 5	3	3	3	0	2	2	3	3	0	1	3	1	3	3	0	2
CO 6	3	1	2	2	1	2	1	0	1	1	1	2	2	2	1	2

Genetics, Plant Breeding and IPR
BOTDE805

Course Outcome:

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

CO1	Outline the knowledge of genetics, plant breeding and IPR.
CO2	Explain the concept of genetics, methods in plant breeding and IPR.
CO3	Apply to gain knowledge on commercially important plants, their breeding systems and strategies employed for crop improvement.
CO4	Analyze the basic concepts of intellectual property rights.
CO5	Evaluate the procedure for obtaining the intellectual property rights.
CO6	Generalized the concept of Genetics, Plant Breeding and IPR

Course Content

Unit	Topic	No. of lectures/hours (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 ant 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
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

- Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
- P.K Gupta. 2016. Genetics. Rastogi Publication, Meerut.
- B.D. Singh. 2018. Genetics and Plant Breeding. Kalyani Publisher, New Delhi.
- Sharma, J.R. (2012). Principles and Practice of Plant Breeding. Tata McGraw Hill Publ. Co. Ltd. New Delhi.
- N.K. Acharya (2001). Textbook on intellectual property rights, Asia Law House.
- Manjula Guru and M.B. Rao (2003). Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
- P. Ganguli (2001). Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
- Miller, A.R. and Davis M.H. (2000). Intellectual Property: Patents, Trademarks and Copyright in Nutshell, West Group Publishers.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	2	1	2	2	2	3	2	1	1	3	2	3
CO2	3	3	2	2	1	2	2	2	0	2	3	0	2	2	0	2
CO3	3	2	2	0	2	2	3	2	3	1	0	2	2	2	3	1
CO4	3	3	2	2	2	1	1	0	2	3	2	2	3	3	2	1
CO5	2	2	2	1	1	0	2	3	2	1	1	2	2	2	0	2
CO6	2	2	2	3	1	2	2	2	3	0	1	3	2	3	1	0

Practical/Lab Course
BOTDL806

Course Outcome:

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

CO1	Outline the knowledge of terms associated with Genetics and Plant Breeding
CO2	Explain the process of sex-linked inheritance
CO3	Apply knowledge to study floral biology of crops
CO4	Analyze applications of common plant breeding techniques
CO5	Evaluate dockage and purity percent of seed
CO6	Compile problems related to genetics and plant breeding.

Course Content

Unit	Topic	Total No. of lectures/hours 30
1	Genetical problems on Mendelian and post- Mendelian ratios, gene interactions, sex-linked inheritance, chromosomal mapping, etc.	6
2	Application of common plant breeding techniques	10
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	4

Suggested Readings

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

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	1	2	1	2	2	2	2	2	1	1	3	2	2
CO2	3	1	2	2	0	2	2	2	0	2	3	0	2	2	0	2
CO3	3	2	2	1	2	2	0	2	3	0	0	2	2	2	3	2
CO4	3	0	2	2	2	0	1	0	2	3	2	2	3	0	2	0
CO5	2	2	0	1	1	3	2	3	2	1	0	2	2	2	3	2
CO6	2	2	2	0	1	2	2	2	0	1	1	2	2	3	1	2

Fresh Water Algal Flora of Himalaya
BOTDE807

Course outcomes:

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

CO1	Outline the taxonomic keys for identifying different floral diversity in the Himalayan region.
CO2	Explain freshwater diatoms and their taxonomic terminology will be useful and will have a brief insight.
CO3	Examine floral diversity, which plays many important and beneficial roles in freshwater ecosystems of the Himalayan regions
CO4	Compare characters of Green, blue-green algae and their taxonomic terminology
CO5	Summarized the Fresh water algal flora of Himalayan region.
CO6	Generalized the concept of Fresh water algal flora of Himalaya

Course Content

Unit	Topic	No. of lectures/ hours (45)
1	**Characters & Keys:** Green and Blue-Green Algae: Taxonomy terminology, flora in Himalaya Macrophytic vegetation. Centrale and Pennale diatoms, diatom taxonomy terminology. Centrale diatom Families and Genera Melosira, Cyclotella in Himalaya. Araphid Family & genera Fragilaria, Diatoma, Meridion, Hannae in Uttarakhand Himalaya.	10
2	**Characters of raphidiod and monoraphidiod families:** Raphidiod: Eunotia Monoraphids, Achnanthaceae – Achnanthidium, Cocconeis	10
3	**Characters of naviculoid biraphid families**: Naviculoid diatom flora Naviculaceae: Navicula & Cymbella sensulato & sensustricto, Gomphonema Other naviculoid diatom flora: Diploneis, Pinnularia, Caloneis	10
4	**Characters of non-naviculoid biraphid families:** Bacillariaceae Nitzschia, Denticula Epithemiaceae: Epithemia Surirellaceae: Surirella Algal communities in Himalayan lotic, lentic systems, wetlands Ecological preferences of abundant forms of Himalaya (OMNIDIA)	15

Suggested Readings

- Fresh water Diatoms of Central Gujarat (with a review and some others). H P Gandhi, Bishen Pal Singh, Mahendra Pal Singh, Dehradun
- Algal flora of Andaman & Nicobar Prasad & Srivastava
- Ganga: A water marvel, A.C. Shukla and A. Vandana, Ashish Publishing House, New Delhi
- Bellinger, E.G., Sigee, 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.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	3	1	1	0	2	2	3	2	3	3	1	3
CO2	3	2	2	2	2	1	2	2	1	2	1	0	3	3	1	1
CO3	2	.1	2	2	2	3	2	3	0	2	2	1	1	2	2	0
CO4	2	1	0	2	1	0	2	2	3	2	0	3	2	2	0	3
CO5	2	1	1	2	0	2	2	2	2	0	2	2	2	0	2	2
CO6	3	2	2	2	1	3	0	1	0	2	1	2	2	2	2	0

Practical/Lab Course
BOTDL808

Course Outcome:

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

CO1	Outline the knowledge of different genera of algae.
CO2	Explain about the members belong to different classes of algae
CO3	Develop the Cultivation of algae of commercial importance
CO4	Analyze different groups of algae
CO5	Evaluate methods of identification of Himalayan flora
CO6	Write methods to isolate fresh water algae

Course Content

Unit	Topic	Lectures/ Hours (30)
1	Cultivation of algae of commercial importance. Study of representative genera of different families viz., Melosira, Cyclotella, Fragilaria, Diatoma, Meridion, Achnanthidium,Cocconeis, Navicula & Cymbella, Gomphonema, Diploneis, Pinnularia, Caloneis, Nitzschia, Denticula, Green and Blue-Green Algae	20
2	Collection and Diversity of algae in lotic and lentic water streams of Himalayan region and their documentation	10

Suggested Readings

- Bellinger, E.G., Sigee, 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.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	3	3	0	3	2	2	0	2	3	3	1	2
CO2	3	2	2	2	2	1	2	2	1	2	1	0	3	3	1	0
CO3	2	.1	2	2	2	0	2	0	0	2	2	1	1	2	2	2
CO4	2	1	3	2	1	3	2	2	3	2	0	3	2	2	0	2
CO5	2	1	1	0	3	2	2	2	2	0	2	2	2	0	2	2
CO6	3	2	2	2	1	0	1	0	0	2	1	2	2	3	2	0

Environment Microbiology
BOTDE809

Course Outcome

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

CO1	Identify the knowledge of Fundamentals of Microbial Ecology and impact of microbes on environment.
CO2	Describe the metabolic processes of microorganisms related to the environment.
CO3	Explain the concept of host-pathogen interaction and impact of microbes on environment.
CO4	Analyze the diversity of Microbes in different environment
CO5	Summarized the role of microorganisms in pollution control and bioremediation
CO6	Demonstrate awareness of pollution control and environment regulations

Course Content

Unit	Topic	Lectures/ Hours (45)
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 for food and food processing	9
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

- Alexander, M. Microbial ecology. John Wiley and Sons, New York.
- Eldowney, S., and Waites, S. Pollution: Ecology and bio treatment. Longman, Harlow.
- Marshal, K.C. Advances of microbial ecology. Plenum Press, New York.
- Maier, R.M., Pepper, I.L., Gerba, C.P. (2015). 3rd Edition. Academic Press (Elsevier).

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	3	2	2	1	1	1	2	1	1	3	3	3	1	2
CO 2	3	3	2	0	3	2	2	1	0	2	2	0	1	1	2	2
CO 3	2	2	2	2	2	2	0	2	2	0	1	2	1	0	2	0
CO 4	1	3	2	2	2	0	2	0	3	2	2	2	2	3	2	1
CO 5	2	0	2	0	2	3	0	1	0	2	2	1	2	1	2	3
CO 6	3	2	1	2	0	2	2	0	3	2	0	0	3	2	2	0

Practical/Lab Course
BOTDL810

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

CO1	Distinguished the pollen grains from different morpho-types, fresh water algae, plant pathogens and microbes.
CO2	Explain the pollen grains morpho-types, types of fresh water algae, plant-pathogens and microbes.
CO3	Apply the knowledge of in vivo and in vitro germination of pollen grains. Study different plant pathogens, diseases and microbes.
CO4	Analyze the isolate some important pollen grains, plant pathogen, fresh water algae and microbes.
CO5	Evaluate the isolation of Fungi/bacteria by the Pour- plate method, spread-plate and streak plate method.
CO6	Develop the knowledge the problem related pollen morphology and ecology, algae, microbes and plant pathogens.

Course Content

Unit	Topic	No. of Lectures / Hours (30)
1	Sampling and enumeration techniques for microbes.	4
2	Determination of total microbial count in a water sample.	4
3	To prepare the Nutrient Agar/CDA/MEA medium for culturing bacteria and Fungi present in our surroundings.	4
4	Isolation of Fungi/bacteria by the Pour- plate method, Spread-pate and Streak Plate method.	6
5	To prepare the differential medium (MacConky) so as to grow the bacteria.	2
6	Isolation of fungi from the given sample of water and soil.	6
7	Working principle molecular technique–PCR, Autoclave, Centrifuge, LAF etc	4

Suggested Readings

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	1	2	2	2	2	1	2	1	2	3	2	1	1	3	2	1
CO 2	1	0	2	2	1	2	2	2	3	2	3	0	2	2	0	2
CO 3	3	2	0	0	2	2	0	2	3	0	0	2	2	2	3	0
CO 4	3	3	2	2	2	0	1	0	2	3	2	3	3	0	2	2
CO 5	1	2	2	1	1	3	2	3	2	1	1	2	2	2	3	1
CO 6	2	2	2	3	1	2	2	2	0	0	1	0	2	0	1	2

Research Publication and Ethics BOTDE811
Semester-VIII
(For Honors with research)

Course outcomes:

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

CO1	Describe the basics of philosophy of science with research ethics
CO2	Explain important issues in research ethics, integrity & scientific misconduct
CO3	Apply the best practices for publications, publication ethics and identify the predatory**,** publishers & journals.
CO4	Analyze the study related to the use plagiarism software tools, citation databases and research metrics.
CO5	Evaluating the properties of mechanism of Research Publication and Ethics
CO6	Constructing the Research Publication and Ethics

Course Content

Unit	Topic	No. of Lectures/hours (45)
1	**Meaning &Functions of Research** 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	12
2	**Research Problem and Research Design** Ethics: Definition with respect to science and research, Intellectual honesty and research integrity Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data	10
3	**Interpretation and Report Writing** 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	10
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

Suggested readings:

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

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	1	1	2	2	0	2	1	2	3	2	1	2
CO2	2	1	1	0	0	2	2	0	3	2	1	2	3	3	0	1
CO3	1	2	2	2	3	1	2	2	2	0	2	2	3	2	3	2
CO4	3	3	1	3	2	2	1	0	2	3	2	2	2	0	2	0
CO5	3	2	2	0	2	2	2	3	2	2	0	0	2	2	2	2
CO6	3	2	0	2	2	2	2	0	2	2	1	2	2	1	0	2

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

Course Outcome

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

CO1	Define the diversity of different microbes including viruses, Algae, Fungi, bryophytes, Pteridophytes.
CO2	Explain the economic importance of different microbes including viruses, Algae, Fungi, bryophytes, pteridophytes.
CO3	Prepare life cycles of microbes including viruses, Algae, Fungi, bryophytes, Pteridophytes.
CO4	Analyze general characters of microbes including viruses, Algae, Fungi, bryophytes, Pteridophytes.
CO5	Summarize the classification of the plants including microbes enterprise of microbial products. Host –pathogen relationship and disease management.
CO6	Construct life cycles of fungi, algae, bryophytes, Pteridophytes.

Course Content

Unit	Topic	Lectures/ 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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	3	3	2	3	0	2	3	3	3	3	2	2	2	1
CO 2	3	3	0	3	1	3	3	3	2	0	0	1	1	2	0	2
CO 3	3	3	3	0	3	0	3	3	0	3	3	3	3	0	3	0
CO 4	3	0	3	2	0	3	3	0	3	2	2	0	3	1	3	1
CO 5	3	3	3	3	2	2	3	3	3	3	3	3	2	3	0	2
CO 6	3	1	3	2	3	1	1	3	1	1	2	2	2	2	1	2

SEMESTER-II
Plant Science-II (BOTGE203)

Course Outcome

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

CO1	Define the terminology associated plant science.
CO2	Explain the classification of taxonomy and general concept of plant anatomy and embryology.
CO3	Apply the knowledge of Gymnosperms, taxonomy, embryology and anatomy in plant science.
CO4	Differentiate the terms related to Gymnosperms, taxonomy, embryology and anatomy in plant science.
CO5	Summarize the process involved in Gymnosperms, taxonomy, embryology and anatomy in plant science.
CO6	Construct a herbarium for the identification and documentation of plants.

Course Content

Unit	Topic	Lectures/ 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 secretary 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.
- 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.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	1	1	0	2	1	2	1	1	3	2	2	1
CO2	2	3	0	1	2	2	2	1	0	2	1	2	3	1	1	2
CO3	1	2	3	2	2	0	2	2	3	0	2	2	1	3	2	0
CO4	3	1	2	0	3	2	2	1	2	3	2	2	2	3	1	2
CO5	3	3	2	3	0	2	2	3	2	2	1	2	2	0	2	0
CO6	3	3	2	2	2	2	2	0	2	2	0	2	2	1	0	1

SEMESTER-III
Plant Science-III (BOTGE303)

Course Outcome:

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

CO1	Define terminology related to physiology, biochemistry and plant biotechnology.
CO2	Explain the biochemical, physiological and molecular process in plants.
CO3	Apply plant tissue culture techniques used in molecular biology.
CO4	Analyze the concept of RDT in Plant Biotechnology.
CO5	Summarize the concepts of Photosynthesis and Respiration.
CO6	Generalize the concept of Plant Physiology and Plant Biotechnology

Course Content

S.No.	Topics	Lectures/ 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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	3	3	2	1	3	2	1	2	1	1	3	1	1	2
CO 2	2	2	2	2	0	2	1	2	0	3	2	3	2	2	2	1
CO 3	3	2	2	0	2	1	2	0	3	2	0	2	2	2	2	0
CO 4	3	0	2	2	3	0	2	2	2	0	2	1	3	2	1	2
CO 5	2	2	2	1	2	2	0	2	2	1	2	0	2	2	2	2
CO 6	3	2	0	3	2	2	2	0	2	1	2	0	2	0	0	2

SEMESTER-IV
Plant Science-IV (BOTGE403)

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

CO1	Define the term associated with biodiversity, conservation, plant breeding and utilization of plant resources.
CO2	Explain the concept of plant science in relation to biodiversity, conservation, plant breeding and utilization of plant resources.
CO3	Apply the process and methods involved in biodiversity conservation and plant breeding.
CO4	Differentiate in-situ and ex-situ conservation.
CO5	Summarize concept of climate change and Mendelian genetics
CO6	Develop problem solving skills through ecological and socio-economic case studies.

Course Content

S.No.	Topics	Lectures/ Hours (45)
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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	3	3	2	1	3	2	3	2	1	1	3	3	0	2
CO 2	2	3	2	2	0	2	1	2	0	3	0	3	2	2	2	2
CO 3	3	2	2	0	2	1	2	0	3	2	3	2	2	2	2	2
CO 4	3	3	2	2	3	1	2	2	2	0	2	1	3	2	1	0
CO 5	2	2	2	1	2	2	0	2	2	1	2	3	2	2	2	2
CO 6	3	2	0	3	2	2	2	3	2	1	2	0	2	3	0	2

SEMESTER-V
Medicinal Plant Diversity of Uttarakhand
(BOTGE505)

Course outcomes:

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

CO1	Define various types of medicines with their functions.
CO2	Explain the diversity and distribution of medicinal plants in Uttarakhand.
CO3	Apply the techniques/methods for the sustainable utilization of the medicinal plants.
CO4	Analyze the economic importance of medicinal plants.
CO5	Summarize the botanical name, family and plant parts used for human welfare.
CO6	Design green house for nursery preparation of medicinal plants

Course Content

Unit	Topic	No. of lectures/ hours (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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	2	2	2	2	1	0	2	1	2	3	2	0	2
CO 2	1	3	2	2	1	2	2	2	3	2	0	3	2	2	2	2
CO 3	3	2	2	0	2	2	0	2	0	1	2	2	2	0	2	0
CO 4	2	1	2	2	2	0	1	3	2	0	2	2	3	2	1	2
CO 5	1	0	2	1	0	3	2	3	2	1	2	3	2	2	2	1
CO 6	3	3	2	3	1	2	2	2	1	3	2	3	2	3	1	0

Global Climate Change
(BOTGE605)

Course outcomes:

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

CO1	Define the concept of climate change and Green house effect.
CO2	Destinguish between the components of ecosystem.
CO3	Explain measures being taken for the mitigation of climate changes.
CO4	Analyze impacts of climate change on ecosystem, forest, sea level, human health.
CO5	Summarize carbon foot print and carbon sequestration.
CO6	Categorize the various protocols and acts of global climate change.

Course Content

Unit	Topic	Total No. of lectures/ hours (45)
1	General concept of Global climate change; Greenhouse effect; Greenhouse gasses; Carbon foot print, Carbon sequestration.	15
2	Impact of global warming and climate change, weather extremes, ecosystem disruption, human health, sea level rise and impact on forests	10
3	International initiative for mitigating global changes; Inter governmental panel on climate change (IPCC); United Nation Frame work convention on Climate change	10
4	Kyoto protocol; Montreal protocol; Paris Pact; India's initiatives for mitigating climate change.	10

Suggested readings

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	1	2	2	2	2	2	0	3	2	1	2	3	2	3	2
CO 2	1	3	2	2	1	2	2	2	0	2	0	3	2	2	2	1
CO 3	1	2	0	3	2	2	3	2	3	0	1	2	2	2	2	2
CO 4	2	1	2	2	2	0	0	3	2	3	2	2	3	2	1	2
CO 5	1	0	2	1	1	3	2	3	2	0	2	3	2	2	2	1
CO 6	3	1	2	0	1	2	2	2	0	1	2	3	2	3	3	1

ABILITY ENHANCEMENT COURSES
SEMESTER-I
Environment Science-I
AEC-104

Course Outcome:

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

CO1	Describe knowledge in ecological perspective and value of environment.
CO2	Explain the significance of various natural resources and its management
CO3	Demonstrate a comprehensive Understanding of the world's biodiversity and the importance of its conservation.
CO4	Analyze different types of pollutions and their control measures. Discover effective methods of waste Management
CO5	Evaluate global environmental problems and come out with best possible solutions.
CO6	Write environmental laws and sustainable development

Course Content

Unit	Topic	Lectures/ 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

- Benny Joseph, (2006).Environmental Studies, Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1 st Edition,.
- Erach Bharucha, (2013). Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition
- P. D Sharma, (2001)"Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition,

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	0	2	1	0	3	2	1	0	1	1	3	2	1	2
CO 2	2	2	1	2	0	1	2	0	2	2	3	0	1	2	0	0
CO 3	2	0	1	1	3	2	0	2	1	1	0	2	2	1	3	2
CO 4	1	2	2	0	0	2	1	1	0	2	1	1	2	0	1	2
CO 5	2	3	2	1	2	0	2	3	2	3	0	1	3	2	2	0
CO 6	1	0	3	0	2	2	1	0	2	0	2	2	2	1	0	2

SEMESTER-II
Environment Science-II
AEC-204

Course Outcome:

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

CO1	Describe knowledge in ecological perspective and value of environment.
CO2	Explain the significance of various natural resources and its management
CO3	Demonstrate a comprehensive Understanding of the world's biodiversity and the importance of its conservation.
CO4	Analyze different types of pollutions and their control measures. Discover effective methods of waste Management
CO5	Evaluate global environmental problems and come out with best possible solutions.
CO6	Write environmental laws and sustainable development

Course Content

Unit	Topic	Lectures/ 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 rules2016, 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, 1 st Edition, 2006.
- Erach Bharucha (2013).Textbook of Environmental Studies for Under Graduate Courses, Orient Black Swan, 2nd Edition, 2013.
- P. D Sharma, (2001).Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	1	2	2	0	2	2	1	0	1	1	2	2	0	2
CO 2	1	2	0	0	1	2	1	1	2	2	3	0	2	2	1	2
CO 3	2	1	3	2	3	1	0	2	1	1	0	2	2	0	1	1
CO 4	2	0	1	2	3	0	1	1	0	2	1	1	1	2	2	0
CO 5	3	2	2	0	2	2	0	0	2	3	0	1	2	3	2	1
CO 6	2	1	0	2	3	1	1	0	2	0	2	2	1	0	3	0

SEMESTER-III
English Communication-I
AEC304

Course Outcomes

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

CO1	Recognize the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.
CO2	Explain principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
CO3	Applying 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.
CO4	Analyzing, 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.
CO5	Summarize the use of English grammar.
CO6	Develop individual and group communication activities; and determine and invent new forms and methods of communication to as per the situation

Course Content

Unit	Topic	Lectures/ 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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	1	2	2	2	2	2	0	3	2	1	2	3	2	3	2
CO 2	1	3	2	2	1	2	2	2	0	2	0	3	2	2	2	1
CO 3	1	2	0	3	2	2	3	2	3	0	1	2	2	2	2	2
CO 4	2	1	2	2	2	0	0	3	2	3	2	2	3	2	1	2
CO 5	1	0	2	1	1	3	2	3	2	0	2	3	2	2	2	1
CO 6	3	1	2	0	1	2	2	2	0	1	2	3	2	3	3	1

SEMESTER-IV
English Communication-II
AEC404

Course Outcomes

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

CO1	Recognize the different techniques of word formation, synonyms, antonyms and skills of sensible writing.
CO2	Explain the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
CO3	Applying the detailed processes of essential techniques and features of effective writing.
CO4	Analyzing the detailed study related common errors in English and solve exercises based on them.
CO5	Evaluating use of English grammar.
CO6	Developing individual and group communication activities as per the situation.

Course Content

Unit	Topic	Lectures/ 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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	1	2	2	2	2	2	0	3	2	1	2	3	2	0	2
CO 2	1	3	2	2	1	2	2	2	0	2	0	3	0	1	2	0
CO 3	1	2	0	3	2	2	3	2	3	0	1	2	2	2	2	2
CO 4	2	1	2	2	2	0	0	3	2	3	2	2	0	2	1	2
CO 5	1	0	2	1	1	3	2	3	2	0	2	3	2	2	2	1
CO 6	3	1	2	0	1	2	2	2	0	1	2	3	2	0	0	1

SKILL ENHANCEMENT COURSES SEMESTER-I
Nursery and Gardening
BOTSC105

Course Outcomes:

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

CO1	Describe the objectives and scope of Nursery, Gardening and cultivation of various vegetables.
CO2	Explain about the structure and types of seed, seed dormancy, Seed production technology, seed testing and certification etc.
CO3	Illustrate the methods of Nursery, Gardening and vegetative propagation.
CO4	Analyze the definition, objectives and scope of different types of Nursery & gardening
CO5	Summarized the knowledge sowing and raising of seeds and seedlings, transplanting And cultivation of seedlings and marketing procedures of vegetables.
CO6	Design the idea of Nursery and Gardening.

Course Content

Unit	Topic	No. of lectures/ hours (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. (2020). Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	1	2	2	1	2	0	2	2	2	3	2	0	1	2	2	2
CO 2	1	3	2	2	1	2	2	2	0	2	3	3	2	2	1	0
CO 3	3	2	2	0	2	2	0	2	3	0	0	2	2	2	0	3
CO 4	3	3	0	2	2	3	1	0	2	3	2	0	3	0	2	2
CO 5	1	0	2	1	0	0	2	3	2	0	1	2	2	2	3	2
CO 6	2	2	2	0	1	2	2	2	0	3	1	3	2	3	1	3

SEMESTER-II

Conservation and Management of Biodiversity

BOTSC205

Course Outcome:

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

CO1	Outline the term associated with conservation and management of biodiversity.
CO2	Explain causes of loss of biodiversity and its management
CO3	Prepare a list of plants and its role in human welfare and biodiversity conservation.
CO4	Analyze the functions of government acts and bodies for the conservation
CO5	Summarize the principles and strategies of conservation
CO6	Write social approaches of conservation of biodiversity

Course Content

Unit	Topic	No. of lectures/ hours (45)
1	**Plant diversity and its scope-** Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.	10
2	**Loss of Biodiversity:** Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations.	15
3	**Conservation of Biodiversity:** Principles and strategies of conservation; In situ and ex situ conservation, Social approaches to conservation, Biodiversity awareness programmes..	10
4	**Role of plants in relation to Human Welfare; Cereals-** Wheat, Rice, Maize; Pulses- A general account; Fruits- A general account with special reference to Uttarakhand Himalaya; Alcoholic beverages. Importance of forestry its utilization and commercial aspects, Wood: Timber yielding plants of Uttarakhand Ornamental plants of India.	10

Suggested Readings

- Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity – Principles and Practices.
- Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
- V.S. Ramachandran. (2013). Plant Diversity and Conservation, Raj Publication

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	3	1	2.	0	2	0	3	2	1	2.	1	2	1	0
CO 2	3	1	2	2	2	3	2	2	2	1	2	0	2	0	2	1
CO 3	1	1	0	1	0	1	2	2	2	1.	0	1.	2	2	0	1
CO 4	2	3	1	2	1	2	2	3	2	0	2	2	3	0	2	2
CO 5	2	2	2	2	3	2	0	2	0	1	1	2	3	2	0	1
CO 6	2	3	1	0	2	2	2	0	1	0	2	2	2	1	1	2

SEMESTER-III
Biofertilizers
BOTSC305(a)

Course Outcomes:

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

CO1	Discuss the knowledge of classification, characteristics and culture maintenance of microbes used as biofertilizers
CO2	Explain about the green manuring, organic fertilizers, , characteristics and culture maintenance of Rhizobium and Azotobacter, Mycorrhizal association
CO3	Applying the knowledge about the role of Mycorrhizal associations in influencing the growth and yield of crop plants, isolation, identification, mass multiplication of Biofertilizers.
CO4	Analyze the General account and factors affecting growth of microbes used as Biofertilizer
CO5	Summarized the recycling of biodegradable waste materials, methods of making biocompost and vermicomposts.
CO6	Write the idea of making Biofertilizers.

Course Content

Unit	Topic	No. of lectures/ Hours (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
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

Suggested Readings

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	1	2	2	2	3	1	3	2	3	2	3	2	0	1
CO 2	1	1	2	2	0	2	2	2	0	2	0	0	2	2	2	2
CO 3	3	2	2	0	2	2	0	2	3	1	3	2	2	0	2	2
CO 4	2	1	1	2	2	2	1	0	2	0	2	2	3	2	1	0
CO 5	1	0	2	1	1	0	2	3	2	1	0	3	2	2	2	3
CO 6	3	1	2	3	1	2	2	2	3	0	2	0	2	0	3	2

Disaster Management
BOTSC305 (b)

Course Outcomes:

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

CO1	Define the key concepts of hazards, disasters, vulnerability, and risks, including the various types of natural and manmade disasters.
CO2	Describe the characteristics, causes, and effects of major natural disasters (earthquakes, floods, droughts, landslides, cyclones, volcanoes) and manmade disasters (gas leaks, radiations leaks, toxic waste, disposal, oil spills, forest fires).
CO3	Use knowledge of disaster types, hazard mapping, and risk assessment tools (including GIS and Remote Sensing) to analyze reallife disaster scenarios.
CO4	Differentiate between types of disasters, their management strategies, and the roles of various stages in the disaster management cycle (rescue, relief, rehabilitation, reconstruction, prevention, mitigation, preparedness).
CO5	Predict the potential impacts of specific hazards on vulnerable communities using seismic zone data, flood/drought patterns, and environmental indicators.
CO6	Prepare disaster management and community awareness plans incorporating early warning systems, mitigation measures, and safe practices for disaster resilience.

Course Content

Unit	Topic	No. of lectures/ hours (45)
1	**Hazards and Disaster**- Concepts, Vulnerability, and risks, Hazard and disaster types- Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes. Man-made disasters: gas and radiations leaks, toxic waste disposal, oil spills, forest fires.	10
2	**Earthquakes and its types,** magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landside and its types	10
3	**GIS and Remote Sensing:** Concepts and stages in the acquisition of remote sensing data; Spectral signature, Photographic and non-photographic sensors, Space Platforms. Basics of Global Positioning System, GPS Satellites and GPS utility. Application of remote sensing in ecological and forestry research.	10
4	**Disaster management Cycle:** Rescue, Relief, Rehabilitation, Reconstruction, prevention, mitigation and Preparedness, awareness generation strategies for the community on safe practices in disaster, Early Warming Systems	15

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Suggested readings

- Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
- Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
- Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	1	2	2	2	3	1	3	2	3	2	3	2	0	1
CO 2	1	1	2	2	0	2	2	2	0	2	0	0	2	2	2	2
CO 3	3	2	2	0	2	2	0	2	3	1	3	2	2	0	2	2
CO 4	2	1	1	2	2	2	1	0	2	0	2	2	3	2	1	0
CO 5	1	0	2	1	1	0	2	3	2	1	0	3	2	2	2	3
CO 6	3	1	2	3	1	2	2	2	3	0	2	0	2	0	3	2

Ethnobotany
(BOTSC405)

Course Outcome

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

CO1	Define concept, scope and relev ance of herbal drugs in Indian system of medicine
CO2	Explain the techniques for drug evaluation standardization and quality control of herbal drugs
CO3	Apply the technique of medicinal gardening - Cultivation practices, marketing and utilization of selected medicinal plants
CO4	Evaluate the chemical constituents, therapeutical and pharmaceutical uses of medicinal plants
CO5	Summarize the legal aspects of ethnobotanical studies
CO6	Explain the role of ethnic groups in conservation of plant genetic resources and in forest management

Course Content

Unit	Topic	No. of lectures/ hours (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 ethno botanical practices (along with their habitat and morphology) a) Azadiracta indica b) Ocimum sanctum c) Vitex negundo. d) Gloriosa superbae) Tribulus terrestris f) Pongamia pinnatag) Cassia auriculata h) Indigofera tinctoria. Role of ethnobotany in modern medicine with special example Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania.	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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	1	2	2	2	2	1	3	2	0	1	3	2	0	2
CO 2	1	3	2	2	0	2	2	2	0	2	3	0	2	2	2	2
CO 3	3	2	2	0	2	2	0	2	3	1	0	2	2	0	2	0
CO 4	2	1	0	2	2	0	1	3	2	0	2	1	3	2	1	2
CO 5	1	3	2	1	1	3	2	0	2	1	2	0	2	2	2	1
CO 6	3	3	2	3	0	2	2	2	2	0	2	3	2	3	0	0

Mushroom Cultivation
BOTSC506

Course Outcome:

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

CO1	Describe the history and scope of mushroom cultivation
CO2	Explain the economic importance of mushroom cultivation
CO3	Apply the basic tools and techniques used in mushroom cultivation
CO4	Analyze about the cost benefit ratio, marketing in India and abroad and export value of Mushroom
CO5	Evaluate about processing of edible mushrooms.
CO6	Summarize the skills for commercial enterprise of mushroom cultivation

Course Content

Unit	Topic	No. of lectures / hours (45)
1	**Introduction:** history, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India – *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*	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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	2	1	1	3	2	0	2	1	2	3	2	2	3
CO 2	2	3	1	0	0	2	0	0	3	2	1	2	3	0	1	2
CO 3	1	2	0	2	3	2	2	2	2	0	2	2	3	2	0	2
CO 4	2	3	3	3	2	2	2	3	2	3	2	2	2	0	2	2
CO 5	3	2	1	0	2	0	2	0	2	2	1	2	2	2	2	2
CO 6	3	2	0	2	2	2	2	1	2	2	1	2	2	1	2	2

SEMESTER-VI
Herbal Technology
BOTSC606

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

CO1	Define role of medicinal plants, their cultivation, harvesting, processing, storage, marketing and utilization.
CO2	Explain uses of herbs in curing various ailments.
CO3	Apply the knowledge of phytochemistry of medicinal plants.
CO4	Analyze the systematic position and medicinal uses of some important plants like Tulsi, Ginger, Fenugreek, Indian Goose Berry and Ashoka.
CO5	Evaluate drug adulteration- types and methods of drug evaluation biological testing of herbal drugs for secondary metabolites
CO6	Plan to cultivate medicinal plants in lab through micropropagation.

Course Content

Unit	Topic	No. of lectures/ hours (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.	10
2	**Pharmacognosy:** systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka	10
3	**Phytochemistry:** active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (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). Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy)	13

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2.	2	2	2	3	1	3	2	1	1	3	2	0	1
CO 2	1	0	2	2	1	2	2	2	0	2	3	0	2	2	2	0
CO 3	3	2	2	0	2	2	0	2	3	1	0	2	2	0	2	3
CO 4	2	1	2	2	2	2	1	0	2	0	2	2	3	2	1	2
CO 5	1	3	2	1	1	0	2	3	2	1	2	3	2	2	2	0
CO 6	3	3	2	3	1	2	2	2	1	3	2	0	2	3	0	2

DISSERTATION

SEMESTER-VII & VIII

Dissertation on Major Core/Minor Elective (from VII & VIII Semester papers)

OR Academic Project/ Entrepreneurship

Course Outcome:

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

CO1	Describe the subject knowledge.
CO2	Explain the scientific temperament.
CO3	Apply the fundamentals of research methodology.
CO4	Illustrate skills for the writing of thesis and scientific papers
CO5	Summarize the knowledge of course work.
CO6	Write 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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	2	2	2	2	1	1	1	2	1	1	3	2	3	0
CO 2	1	3	2	2	1	0	2	2	0	2	3	3	2	2	2	3
CO 3	3	2	2	0	2	2	0	2	3	1	0	2	2	0	2	2
CO 4	2	1	2	2	2	2	1	3	2	0	2	2	3	2	1	1
CO 5	1	0	2	1	0	3	2	0	2	1	2	3	2	2	2	0
CO 6	3	3	2	3	1	2	2	2	1	3	2	0	2	3	3	1

VAC-1 Indian Knowledge System

Course Outcomes

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

CO1	Define key concepts, historical foundations, and significant figures of the Indian Knowledge System (IKS), including Vedic, Ayurvedic, philosophical, and scientific traditions
CO2	Demonstrate a comprehensive understanding of the core principles, methodologies, and the relevance of Indian Knowledge Systems
CO3	Apply principles from Indian Knowledge Systems to solve real-world problems
CO4	Analyze various schools of Indian knowledge, identifying connections, distinctions, and their impact on modern thinking.
CO5	Evaluate the role and significance of Indian Knowledge Systems in addressing global challenges and contemporary issues.
CO6	Plan innovative solutions or new approaches that integrate Indian Knowledge Systems with contemporary practices and interdisciplinary fields

Course Contents

Unit	Topic	No. of lectures/ hours (20)
1	**Introduction to Indian Knowledge System (IKS):** Definition, Concept and Scope of IKS: Definition, Concept and Scope of IKS; IKS based approaches on Knowledge Paradigms; IKS in ancient India and in modern India	3
2	**IKS and Indian Scholars, Indian Literature:** Philosophy and Literature (Maharishi Vyas, Manu, Kanad, Pingala, Parasar, Banabhatta, Nagarjuna and Panini); Mathematics and Astronomy (Aryabhatta, Mahaviracharya, Bodhayan, Bhashkaracharya, Varahamihira and Brahmgupta); Medicine and Yoga (Charak, Susruta, Maharishi Patanjali and Dhanwantri); Sahitya (Vedas, Upvedas, Upavedas (Ayurveda, Dhanurveda, Gandharvaveda) Puran and Upnishad) and shad darshan (Vedanta, Nyaya.Vaisheshik, Sankhya, Mimamsa, Yoga, Adhyatma and Meditation); Shastra (Nyaya, vyakarana, Krishi, Shilp, Vastu, Natya and Sangeet)	2
3	**Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom:** Geophysical aspects, Resources and Vulnerability; Resource availability, utilization pattern and limitations; Socio-Cultural linkages with Traditional Knowledge System; Tangible and intangible cultural heritage.	5
4	**Unique Traditional Practices and Applied Traditional Knowledge:** Myths, Rituals, Spirituals, Taboos and Belief System, Folk Stories, Songs, Proverbs, Dance, Play, Acts and Traditional Narratives; Agriculture, animal husbandry, Forest, Sacred Groves, Water Mills, Sacred Water Bodies, Land, water and Soil Conservation and management Practices; Indigenous Bio-resource Conservation, Utilization Practices and Food Preservation Methods, Handicrafts.	5
5	**Protection, preservation, conservation and Management of Indian Knowledge System:** Documentation and Preservation of IKS; Approaches for conservation and Management of nature and bio-resources; Approaches and strategies to protection and conservation of IKS	5

Suggested Reading

1. Traditional Knowledge System in lndia. By Amit Jha, Atlantic Publication.
2. Introduction to Indian Knowledge System: concepts and applications. 2022.
3. Mahadevan, B., Bhat, Vinayak Rajat, Nagendra Pavana R.N. PHI Learning Pvt. Ltd

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	0	1	2	1	3	2	0	1	3	2	1	1
CO2	3	1	0	2	2	3	0	3	2	1	2	3	2	0	2	0
CO3	3	1	3	2	2	0	2	3	2	1	2	0	2	2	3	3
CO4	2	3	2	0	1	1	2	0	2	0	2	2	2	3	2	2
CO5	3	2	0	3	3	2	3	2	0	3	1	2	3	2	0	1
CO6	1	3	3	2	2	2	2	0	1	0	2	2	1	1	1	0

VAC-2 Science and Society

Course outcomes

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

CO1	Recognize fundamental concepts, key terms, historical milestones, and major contributors in science and their societal impact.
CO2	Explain the interrelationship between scientific developments and societal changes, including ethical, cultural, and environmental implications
CO3	Demonstrate the application of scientific principles to solve real-world societal problems, using appropriate methods and tools
CO4	Differentiate between scientific facts and opinions; analyze case studies where science has significantly influenced societal development or vice versa
CO5	Summarize scientific policies, technologies, or innovations in terms of their societal impact, sustainability, and ethical considerations.
CO6	Plan innovative solutions or frameworks that integrate scientific understanding with societal needs, fostering sustainable development and responsible citizenship

Course Contents

Unit	Topic	No. of lectures/ hours (20)
1	**Science and Technology – from Ancient to Modern Times**: Philosophy of science, the scientific method, importance of observation, questions and experimental design, rational thinking, myths vs. facts; Science, Technology and Traditional Practices: Suggestive areas include: Water harvesting structures and practices, Construction, architecture and design – use of natural environment-friendly designs and materials, Agriculture including domestication of plants and animals.	**5**
2	**Science and Technology in Modern Times:** Suggestive areas include: Public Health: Nutrition, Hygiene, Physical and Mental Health, Vaccines and Antibiotics, Anti-microbial resistance, Food Security: Green Revolution, White Revolution, IT Revolution, e-Governance, Clean Energy, Renewable Energy, Evolution, Ecology and Environment.	**5**
3	**Scientific Principles and Concepts in Daily Life:** Observing and documenting flora and fauna of College campus/city; Visits to science laboratories in the College or neighbouring College/Institute; Visits to science museums, planetarium; Visits to biodiversity parks and nature walks; Participation in a citizen science project/initiative	**5**
4	**Contemporary Developments:** Climate change and global warming, Threats to biodiversity and habitat degradation, Genomics and modern medicine, Genetically engineered crops, Citizen science and science communication, Science of natural disasters and their management, Artificial intelligence and robotics.	**5**

Suggested Readings

- Basu and Khan (2001). Marching Ahead with Science. National Book Trust
- Gopalakrishnan (2006). Inventors who Revolutionised our Lives. National Book Trust
- Yash Pal and Rahul Pal (2013). Random Curiosity. National Book Trust
- Hakob Barseghyan, Nicholas Overgaard, and Gregory Rupik (****) Introduction to History and Philosophy of Science (licensed under a Creative Commons Attribution 4.0 International License)
- John Avery (2005). Science and Society, 2nd Edition,
- Dharampal (2000). Indian Science and Technology in the Eighteenth Century.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1	2.	3	2	1	0	2	0	2.	1	2	1	3
CO2	3	1	0	2	2	0	2	2	2	1	2	3	2	0	2	0
CO3	1	1	3	0	2	1	2	2	2	1	2	0	2	2	0	1
CO4	2	3	2	2	1	2	2	0	2	3	2	2	3	3	2	2
CO5	2	2	0	2	0	2	0	2	3	3	1	2	0	2	3	2
CO6	2	3	3	2	2	2	2	3	1	0	2	2	2	1	1	2

VAC-3- Swachh Bharat

Course outcomes:

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

CO1	Identify the objectives, mission, and key initiatives of the Swachh Bharat Abhiyan.
CO2	Explain the importance of cleanliness and sanitation in personal, community, and national development.
CO3	Demonstrate basic sanitation and hygiene practices in daily life and promote them in the community.
CO4	Analyze the challenges, gaps, and successes of the Swachh Bharat Abhiyan through case studies and reports.
CO5	Summarize the impact of cleanliness drives and public participation in improving health and environment.
CO6	Design a community-driven cleanliness initiative or campaign promoting sustainable sanitation practices.

Course Contents

Unit	Topic	No. of lectures/ hours (20)
1	**Introduction to Swachh Bharat Abhiyan**: Gandhian philosophy of Cleanliness, Swachh Bharat Abhiyan (SBA), Hygiene, Sanitation & Sustainable Waste Management, Agencies and nodal Ministries for SBA, Different phases of the SBA and its evaluation, Citizens' Responsibilities: Role of Swaccha grahi	**5**
2	**Swachh Bharat:** Rural and Urban Facets: Indicators for Swachh Bharat, Rural Sanitation coverage across households (2014 vs. 2022),	**5**
3	**Open Defecation Free (ODF) Villages:** Parameters, ODF plus model: Key indicators, Urban, Sustainable sanitation, Waste/water and solid waste management, Garbage Free Cities	**5**
4	**Prospects and Challenges:** Attitudes and Perceptions, Operational and Financial issues, Monitoring & Supervision, Community Mobilization	**5**

Suggested Readings

- Mishra, Saurabh. *Swachh Bharat Abhiyan*. Om Publications, 2019. ISBN 978-9384471309.
- Sinha, Mridula (ed.). *Swachh Bharat*. Prabhat Prakashan, 2016. ISBN 978-9351867227.
- Ansari, Taufiq. *Sanitation and Swachh Bharat Abhiyan*. Omega Publications, 2015. ISBN 978-8184555769.
- Shrivastav, Surendra. *Swachh Bharat Mission (Samasyāen aur Samādhān)*. Sakshi Book Distributor, 2023. ISBN 978-9381150061.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	1	1	3	2	1	2	1	2	3	2	2	2
CO2	2	3	0	1	2	2	2	0	3	2	0	2	3	1	1	3
CO3	1	2	3	2	2	0	2	2	0	3	2	2	3	0	2	0
CO4	3	1	2	0	3	2	0	1	2	0	2	2	2	3	1	2
CO5	3	3	2	3	0	2	2	3	2	2	1	2	2	0	2	2
CO6	3	0	2	2	2	2	2	3	2	2	1	2	2	1	0	1

VAC 4: Tribe of India

Course outcomes

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

CO1	Outline the concept of tribe and distinguish it from other social groups in Indian society
CO2	Summarize the historical and organic linkages between Indian tribes and civilization.
CO3	Apply the socio-cultural, economic, religious, and political life of tribal communities.
CO4	Analyze insights of tribal social institutions and their role in promoting the values of justice, co-existence, equality and sustainable living.
CO5	Evaluate government policies, constitutional provisions, and development programs aimed at tribal welfare and upliftment.
CO6	Explain issues and develop a comparative understanding of tribal communities across different regions of India.

Course content

Unit	Topic	No. of lectures/ hours (20)
1	**On the Concept of Tribe in India:** Concept of Tribe, Distribution and classification, Features of tribes in India, Tribes as a significant component of Indian Civilization	**5**
2	**Tribal Social Institutions:** Systems of Kinship, Family and its types, Gender relations, Rules of marriage, Tribal Polity and Indigenous governance	**5**
3	**Tribal Worldview:** Tribal religion and symbolism, Folklore, myths and legends among tribes, Cosmogony and schemas of living, Oral history and tribal poetry, Change and Continuity	**5**
4	**Tribes and National Freedom Movement and government policies:** Tribal movements and protests during colonial rule, Cultural, social, and political impact of Tribal movement, Role of tribes in India's freedom Struggle, Evaluate government policies, constitutional provisions, and development programs aimed at tribal welfare and upliftment.	**5**

Suggested reading

- Vidyarthi L.P., Vinay Kumar Rai ( ).The Tribal Culture of India.
- Nath, P. (2025).Physical Anthropology Book by Covering Human Evolution, Genetics, Development, Adaptation, Demography, Primates Biology, Applied Anthro., Organic Evolution.
- Encyclopaedia of Dravidian Tribes: An Old and Rare Book (Set of 3 Volumes)

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	0	1	2	1	0	2	1	2	3	2	1	1
CO2	3	1	2	2	2	1	2	0	2	1	2	0	2	3	2	2
CO3	3	1	0	2	2	0	2	3	2	1	2	3	2	2	0	3
CO4	2	3	1	0	1	1	2	0	2	3	2	2	2	0	2	2
CO5	3	2	2	3	3	2	0	2	2	3	1	2	3	2	2	1
CO6	1	3	1	2	2	2	2	3	1	0	2	2	1	1	1	0