

DEPARTMENT OF BOTANY
KUMAUN UNIVERSITY, NAINITAL

‘FINAL DRAFT SYLLABUS’
FOR
B.Sc. BOTANY

[AS PER NATIONAL EDUCATION POLICY-2020]

FACULTY OF SCIENCE

2023

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Semester-wise Titles of the Papers in B. Sc (Botany)					
Year	Semester	Course Code	Paper title	Theory/ Practical	Credits
Certificate Course in Basic Botany					
First Year	I	BOT101T	Microbes, Algae, Fungi and Bryophytes	Theory	4
		BOT102P	Practical/Lab course	Practical	2
	II	BOT201T	Pteridophytes, Gymnosperms and Angiosperms	Theory	4
		BOT202P	Practical/Lab course	Practical	2
Diploma Course in Developmental Botany					
Second Year	III	BOT301T	Morphology, Anatomy and Embryology	Theory	4
		BOT302P	Practical/Lab course	Practical	2
	IV	BOT401T	Cytogenetics and Plant Breeding	Theory	4
		BOT402P	Practical/Lab course	Practical	2
Bachelor of Science					
Third Year	V	BOT501T	Molecular Biology and Plant Biotechnology	Theory	4
		BOT502T	Economic Botany	Theory	4
		BOT503 P	Practical/Lab course	Practical	2
		BOT504R	Project I-Local Plant Diversity	Practical	4
	VI	BOT 601T	Physiology and Biochemistry	Theory	4
		BOT602T	Ecology and Biostatistics	Theory	4
		BOT603P	Practical/Lab course	Practical	2
			Project II-Local Ecosystem Studies	Practical	4

N. K. Bhatia
19-06-2023

C. S. R. S.
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B. K. S.
19.6.2023

John
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Year wise Structure of B.Sc. in Botany (Core/elective courses and Projects)											
Subject: Botany											
Course/ Entry-Exit level	Year	Semester	Paper-1	Credits/hrs	Paper-2	Credits/ hrs	Paper-3	Credits/hrs	Research project	Credits /hrs	Total Credits/hrs
Certificate Course in Basic Botany	I	I	Microbes, Algae, Fungi and Bryophytes	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
		II	Pteridophytes, Gymnosperms and Angiosperms	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
Diploma Course in Developmental Botany	II	III	Morphology, Anatomy and Embryology	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
		IV	Cytogenetics and Plant Breeding	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
Bachelor of Science	III	V	Molecular Biology and Plant Biotechnology	4/60	Economic Botany	4/60	Practical /Lab course	2/60	Project-I	4/60	14/240
		VI	Physiology and Biochemistry	4/60	Ecology and Biostatistics	4/60	Practical /Lab course	2/60	Project-II	4/60	14/240

COURSE INTRODUCTION

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

B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects would also be organized for real-life experience and learning. Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

Programme outcomes (POs):

Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery- learning, equipped with practice & skills to deal 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.

PO1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning.
PO2	Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to provide sustainable development.
PO3	Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, enhance communication skill, social interaction, and increase awareness in judicious use of plant resources by recognizing the ethical value system.
PO4	The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET, UPSC Civil Services Examination, IFS, NSC, FCI, BSI, FRI etc.

PO5	Certificate and diploma courses are framed to generate self- entrepreneurship and self- employability, if multi exit option is opted.
PO6	Lifelong learning is achieved by drawing attention to the vast world of knowledge of plants and their domestication.

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

- This certificate course will provide knowledge on 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 habit, habitat, morphology, anatomy and reproduction of various plant groups.

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

- This programme will provide knowledge on plant morphogenesis, anatomy embryology and plant genetics.
- Laboratory sessions following theory will provide easy understanding of internal structure of various plant parts, structural organization, reproductive biology and genetics.
- This course will help students to become a plant morphologist.

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

- The three year learning outcome of graduation will provide understanding of plant systematic, economic botany, developmental biology, ecology, statistics, physiology, biochemistry.
- 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.

DETAILED SYLLABUS OF B.Sc. I YEAR FOR CERTIFICATE COURSE IN BASIC BOTANY

Course	Year	Semester
<i>Certificate Course in Basic Botany</i>	<i>B.Sc. I</i>	<i>I</i>

Paper 1: Microbes, Algae, Fungi and Bryophytes (Course code: BOT101T) Credit: 4

Course Outcome

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

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

Unit	Topic	No. of lectures/ hrs (60)
1	Microbes : Viruses-discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); economic importance; bacteria–discovery, general characteristics and cell structure; reproduction–vegetative, asexual and recombination (conjugation, transformation and transduction); economic importance.	15
2	Algae: General characteristics; Range of thallus organization and reproduction; classification of algae; morphology and life-cycles of: <i>Nostoc</i> , <i>Chlamydomonas</i> , <i>Oedogonium</i> , <i>Vaucheria</i> , <i>Sargassum</i> , <i>Polysiphonia</i> ; economic importance of algae.	15
3	Fungi : Introduction-general characteristics, ecology and significance, range of somatic thallus organization, cell wall composition, nutrition, reproduction and classification (G.C. Ainsworth); life cycle of <i>Stemonitis</i> (Myxomycota)	15

	<i>Rhizopus</i> (Zygomycota) <i>Penicillium</i> (Ascomycota), <i>Puccinia</i> , <i>Agaricus</i> (Basidiomycota); <i>Alternaria</i> (Deutromycota), Symbiotic associations: Lichens- General account, reproduction and significance; Mycorrhiza: ectomycorrhiza, endomycorrhiza and their significance.	
4	Bryophytes: General characteristics, adaptations to land habit, classification (up to family), morphology, anatomy and reproduction of <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> ; ecology and economic importance of bryophytes.	15

Suggested readings

- Barsanti, L. and Gualtieri, P. (2014). Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition. CRC/ Taylor & Francis, NY.
- Lee, R.E. (2018). Phycology, Fifth Edition. Cambridge University Press, Cambridge.
- Marjorie, Kelly and Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw Hill New York, 5th edition.
- Pandey, S.N and Trivedi, P.S. (2015). A text book of Botany Vol.I Vikas publishingHouse Pvt/ Ltd, New Delhi.
- Parihar, N.S. (1991). An Introduction to Embryophyta Vol. I Bryophyta. Central Book Depot, Allahabad.
- Mehrotra, R.S. and K.R. Aneja. (1999). An Introduction to Mycology. New Age International Publisher.
- Pelczar M.J., Chan E.C.S and Kreig N.R. (1997). Microbiology. Tata MacGraw Hill.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGrawHill, Delhi, India.
- Robert Edward Lee. (2018). Phycology. Cambridge University Press, U.K. 5th edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Sharma, O. P. (2011). Algae. Tata McGraw Hill Education Private Limited, U.K. 1st edition.
- Tortora, G.J., Funke, B.R., Case, C.L. (2011). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 13th edition.
- Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Bryophyta, S. Chand. Delhi, India.
- Webster, J. and Weber, R. (2007). Introduction to Fungi. Third Edition. Cambridge University Press. Cambridge and New York.
- Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 11th Edition, McGraw-Hill, USA.

Paper 2: Practical/ Lab course (Course code: BOT102P)

Credit: 2

Course Outcome

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

1. Understand the instruments, techniques, lab etiquettes and practices for working in a microbiology laboratory.
2. Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes.

3. Practical skills in the field and laboratory experiments in Microbiology and Pathology.
4. Learn to identify algae, lichens and plant pathogens along with their symbiotic and parasitic associations.
5. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to Bryophytes.
6. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding diversity, economic values & taxonomy of bryophytes.

Unit	Topic	No. of Lectures/ hrs (60)
1	EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle. Types of Bacteria from temporary/permanent slides/photographs; EM of bacterium; Binary Fission; Conjugation; Structure of root nodule; Gram staining technique	15
2	Study of vegetative and reproductive structures of <i>Nostoc</i> , <i>Chlamydomonas</i> (electron micrographs), <i>Oedogonium</i> , <i>Vaucheria</i> , <i>Sargassum</i> and <i>Polysiphonia</i> through temporary preparations and permanent slides/specimens.	15
3	<i>Rhizopus</i> and <i>Penicillium</i> : Asexual stages from temporary mounts. <i>Alternaria</i> : Specimens/photographs and tease mounts. <i>Puccinia</i> : Herbarium specimens of Black Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on wheat and permanent slides of both the hosts. <i>Agaricus</i> : Specimens of button stage and full grown mushroom. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose). Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs).	15
4	<i>Riccia</i> , <i>Marchantia</i> and <i>Anthoceros</i> : Morphology of thallus, rhizoids and scales, V.S. thallus through gemma cup, gemmae whole mount (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). <i>Funaria</i> - Morphology, whole mount leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S capsule and protonema.	15

Suggested readings

- Bergey's Manual of Systematic Bacteriology, 2nd ed., vol. 1-3, Springer Verlag, New York, NY.
- 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 text book of Algae. I.K International Publishing House, Pvt. Ltd.

Course	Year	Semester
<i>Certificate Course in Basic Botany</i>	<i>B.Sc. I</i>	<i>II</i>

Paper 1: Pteridophytes, Gymnosperms and Angiosperms (BOT201T)

Credit 4 Course Outcome

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

1. Develop critical understanding on morphology, anatomy and reproduction of Pteridophytes, Gymnosperms and Angiosperms.
2. Understanding of plant evolution and their transition to land habitat.
3. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants.
4. To compare the different approaches to classification with regard to the analysis of data.
5. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family.
6. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.

Unit	Topic	No. of Lectures/ hrs (60)
1	Pteridophytes General characteristics, classification (up to family) including The Pteridophyte Phylogeny Group (PPG) classification, early land plants (<i>Rhynia</i>); morphology, anatomy and reproduction of <i>Selaginella</i> , <i>Equisetum</i> and <i>Pteris</i> ; heterospory and seed habit, stelar evolution; ecological and economic importance of Pteridophytes, Telome theory.	15

2	Gymnosperms General characteristics, classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i> ; ecological and economic importance.	15
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, principle of priority and its limitations). Classification: Types of classification-artificial, natural and phylogenetic Bentham and Hooker (upto series), Hutchinson classification and Angiosperm Phylogeny Group (APG IV) classification.	10
4	Taxonomy of plant families: Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Orchidaceae and Poaceae.	20

Suggested readings

- Angiosperm Phylogeny Group (APG-2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1-20.
- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Gangulee H.C., Kar, A.K. and Santra S.C. (2011). College Botany Vol II. 4th Edition New Central Book Agency.
- Pandey, B.P. (2010). College Botany Vol II. S. Chand and Company Ltd., New Delhi, India.
- Parihar, N.S. (1976). Biology and Morphology of Pteridophytes. Central Book Depot.
- Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
- Sambamurty, A.V.S.S. (2010). Taxonomy of Angiosperms. I.K. International Pvt. Ltd.
- Saxena N.B. and Saxena S. (2012). Plant Taxonomy Pragati Prakashan.
- Sharma O.P. (2013). Plant Taxonomy. MC GRAW HILL INDIA.
- Sharma, O.P. (1990). Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
- Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford and IBH Pvt. Ltd., New Delhi. 3rd edition.
- The Pteridophyte Phylogeny Group (PPG Classification) (2016): A community –derived classification for extant lycophytes and ferns. Journal of Systematics and Evolution. 54(6): 563-603. Doi:10.1111/jse.12229
- Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Gymnosperms, S. Chand and Company Ltd., Ramnagar, New Delhi, India.

Course outcomes:

1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants growing in nature and become familiar with the biodiversity.
2. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
3. Understand morphology, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of plant diversity, economic values and taxonomy of plants.

Unit	Topic	No. of Lectures/ hrs (60)
1	<i>Selaginella</i>: Morphology, whole mount leaf with ligule, strobilus, microsporophyll and megasporophyll (temporary slides), T.S. stem, L.S. strobilus (permanent slide). <i>Equisetum</i>: Morphology, T.S. internode, L.S. strobilus, T.S and L.S. Strobilus, whole mount sporangiophore, spores (wet and dry) (temporary slides); T.S. rhizome (permanent slide). <i>Pteris</i>: Morphology, T.S rachis, V.S. sporophyll, whole mount sporangium and spores (temporary slides), T.S. rhizome, whole mount prothallus with sex organs and young sporophyte (permanent slide).	15
2	<i>Cycas</i>: Morphology (coralloid roots, bulbil, leaf), T.S. coralloid root and rachis, V.S. leaflet and microsporophyll, whole mount spores (temporary slides), L.S. ovule, T.S. root (permanent slide). <i>Pinus</i>: Morphology (long and dwarf shoots, male and female cones), T.S. needle and stem, L.S./T.S. male cone, whole mount microsporophyll and microspores (temporary slides), L.S. female cone, TLS and RLS stem (permanent slide).	15
3	Taxonomic Identification: Description of an angiospermic plant, study of vegetative and floral characters (description, V.S. flower, 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.	20

4	Herbarium techniques: Plant collection, preservation and mounting of two properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book), digital/virtual herbarium.	10
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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.

DETAILED SYLLABUS OF B.Sc. II YEAR OR DIPLOMA COURSE IN DEVELOPMENTAL BOTANY

Course	Year	Semester
<i>Diploma Course in Developmental Botany</i>	<i>B.Sc. II</i>	<i>III</i>

Paper 1: Morphology, Anatomy and Embryology

(Course code: BOT301T) Credit: 4

Course outcomes:

1. Understand morphology, anatomy and Embryology.
2. Understand role of tissues in plant functions.
3. Understand the composition, modifications, internal structure & architecture of plants.
4. Understand reproduction and developmental changes in plants.

Unit	Topic	No. of Lectures/ hrs (60)
1	Meristematic and permanent tissues: Types of tissues, Root and shoot apical meristems, Theories related to apical meristem, simple, complex and secretory tissues. Organs: Structure of dicot and monocot root, stem and leaf, root stem transition.	15
2	Adaptive and protective systems: Epidermis, cuticle and stomata Secondary growth: Structure and function of Vascular cambium, secondary growth in stem and roots (Sunflower, Beet root), abnormal secondary growth (Monocot stem: Dracaena; Dicot stem: <i>Achyranthes</i> ,	15

	<i>Amaranthus, Bignonia, Boerhaavia, Bougainvillea, Chenopodium, Mirabilis, Nyctanthes, Salvadoria</i>)	
3	Pollination and fertilization: Pollination mechanisms and adaptation, structure of anther and pollen, development of male and female gametophytes, double fertilization.	15
4	Embryo and endosperm: Types of ovules and embryo sacs; embryo and endosperm; types of endosperm; dicot and monocot embryo; apomixis and polyembryony.	15

Suggested readings

- Beck, C.B. (2010). An Introduction to Plant Structure and Development, II edition.
- Bhatnagar S.P, Dantu, P.K. Bhojwai S.S. (2018). The embryology of Angiosperms. Vikas Publ. House. New Delhi.
- Bhojwani, S.S. and Bhatnagar, S.P. (2010). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
- Fosket, D.E. (1994). Plant, Growth and Development: A Molecular Approach, Academic Press.
- Hopkins, W.G. (2006). The Green World: Plant Development, Chelsea House Publication.
- Johri, B.M. (1984). Embryology of Angiosperms. Springer-Verlag, Berlin.
- Leins, P., Tucker, S.C. and Endress, P.K. (1988). Aspects of floral development. J. Cramer. Germany.
- Maheshwari, P. (1971). An Introduction to Embryology of Angiosperms. McGraw Hill Book Co. London.
- Pandey, B.P. (2001) Plant Anatomy. S. Chand and Company Ltd., New Delhi.
- Raghwan, (1997). Molecular embryology of flowering plants. Cambridge Univ. Press. Cambridge.
- Sharma, M.K. (2013) Plant Structures (An Introduction to Plant Anatomy). VayuEducation of India.
- Sharma, P.C. (2017). Text Book of Plant Anatomy. Arjun Publishing House.
- Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Science Publishers. Verlag.

Paper 2: Practical/Lab Course (Course code: BOT302P)

Credits: 02

Course outcomes:

1. Understand cell structure in monocot and dicot plants.
2. Understand cell structure, secondary growth and adaptive anatomy in plants.
3. Understand the pollination and seed dispersal mechanism.
4. Study the structure of ovules and female gametophytes.

Unit	Topic	No. of Lectures (60 hrs)
1	Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma), complex and secretory tissues. Anatomy of monocot and dicot Stem; monocot and dicot leaf; monocot and dicot root	15
2	Adaptive anatomy: Xerophytes, Hydrophytes, Epiphytes Normal and abnormal secondary growth in different plants	15
3	Pollination types and seed dispersal mechanisms (photographs and specimens)	15
4	Structure of anther (young and mature). Types of ovules: anatropous, orthotropous, circumtropous, amphitropous, campylotropous. Female gametophyte: <i>Polygonum</i> (monosporic) type of embryo sac development (permanent slides/photographs) Ultrastructure of mature egg apparatus cells through electron micrographs (permanent slides/photographs)	15

Suggested readings

- Pandey, B.P. (2014). Modern Practical Botany Vol. II. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Pandey, B.P. (2001). Plant Anatomy. S. Chand and Company Ltd., Ram Nagar, New Delhi.
- Sundara, R.S. (2002). Practical Manual Anatomy and Embryology. Anmol Publisher, New Delhi.

Course	Year	Semester
<i>Diploma Course in Developmental Botany</i>	<i>B.Sc. II</i>	<i>IV</i>

Paper 1: Cytogenetics and Plant Breeding (course code: BOT401 T)

Credit 4 Course outcomes:

1. Understand the structure and chemical composition of chromatin and concept of cell division.
2. Interpret the Mendel's principles; acquire knowledge on cytoplasmic inheritance and sex-linked inheritance.
3. Understand the plant breeding systems and heterosis and mutation in plant breeding.

Unit	Topic	No. of Lectures (60 hrs)
1	Heredity: (Pre-mendelian genetics, brief life history of Mendel, laws of Inheritance, modified mendelian ratios, lethal genes, co-dominance,	15

	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.	
2	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).	15
3	Plant breeding: introduction and objectives; breeding systems, important achievements and undesirable consequences of plant breeding); methods of crop improvement; centres of origin and domestication of crop plants, plant genetic resources; acclimatization; selection methods.	15
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

- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). Molecular Biology of the Cell. Garland Publishing Inc., New York. 6th edition.
- Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991). Principles of Genetics, John Wiley & Sons.
- Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M., Veres, R.C. (2006). Genetics-From Genes to Genomes, McGraw Hill
- Lewin, B. (2008). Genes IX, Jones and Barlett Publishers.
- Lodish, H., Berk, A., Zipursky, S.L., Maztsudaira, P., Baltimore, Dand Darnell, I. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York, USA.
- Rastogi, V.B. (2019). Genetics. 4th Edition. MEDTECH: A Division of Scientific International.
- Russel P. J. (2010). Genetics-A Molecular Approach, Pearson Education Inc.
- Singh R. J. (2002). Plant Cytogenetics, CRC Press.
- Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
- Strickberger M.W. (2008). Genetics, Pearson (Prentice Hall).
- Watson, J.D. (2013). Molecular Biology of the Genes, Benjamin. 7th Edition.

Paper 2: Practical/Lab Course (Course code: BOT402 P)

Credit 4: Course outcomes

1. Interpret the Mendel's principles; and understand the monohybrid and dihybrid crosses and their ratio and chromosomal changes.
2. Learn the basic structure and function of cells and instruments used in molecular biology.

Unit	Topic	No. of Lectures (60 hrs)
1	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). Contribution of Mendel.	15
2	Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs. Photographs/permanent slides showing translocation ring, laggards and inversion bridge.	15
3	Hybridization techniques - Emasculation, Bagging (For demonstration only). Induction of polyploidy in plants (For demonstration only).	15
4.	Techniques used for Crop Improvement. Contribution of Dr. M.S. Swaminathan, T.S. Venkataraman, B.P. Pal, Dharampal Singh, V. Santhanam in plant breeding.	15

Suggested readings

- Singh, R.J. (2021). Practical Manual on Plant Cytogenetics. CRC Press, Taylor and Francis Group, Routledge.

DETAILED SYLLABUS OF B. Sc III YEAR OR BACHELOR OF SCIENCE

Course	Year	Semester
<i>Bachelor of Science</i>	<i>B.Sc. III</i>	<i>V</i>

Paper 1: Cell and Molecular Biology, and Biotechnology (Course code: BOT501T)

Credit 4

Course outcomes:

1. Understand cell structure, nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
2. Know about processing and modification of RNA and translation process, function and regulation of expression.
3. Understand the basic tools and techniques used in Plant tissue culture.

Unit	Topic	No. of Lectures (60 hrs)
1	Cell Biology: The cell theories, prokaryotic and eukaryotic cells, cell organelles (Mitochondria, Chloroplast, ER, golgi body, lysosomes, peroxisomes, glyoxisomes, 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).	18
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, tRNA, rRNA); Translation (Prokaryotes), Regulation of gene expression (Prokaryotes: Lac operon and Tryptophan operon).	18
3	Plant tissue culture: Culture types on the basis of explants and media composition, General lab setup and instrumentation, micropropagation, brief account of protoplast culture, somatic embryogenesis with their applications.	12
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 and Immunodetection.	12

Suggested readings:

- Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M. and Roberts, K. (2014). Molecular Biology of the Cell. CRC Press, Taylor & Francis Group, USA.; 1464 pages
- Berk, A., Kaiser, C.A., Lodish, H., Amon, A., Ploegh, H, Bretscher (Author), Monty Krieger, A., Martin, K.C. (Eds). (2016) Molecular Cell Biology. Freeman & Co., USA.
- Brown, T. A. (2017). Genomes 4. CRC Press, Taylor & Francis Group, USA.
- Buchanan, B.B., Gruissem, W. and Jones, R.L (2015). Biochemistry and molecular biology of plants. Wiley Publisher; pages: 1264p
- 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.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc.

Paper 2: Economic Botany (Course code: BOT502T) Credit: 4

Course outcomes

1. Know about the importance of medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.

Unit	Topic	No. of Lectures (60 hrs)
1	Origin of cultivated plants (concept of centres of origin, their importance with reference to Vavilov's work)	15
2	A brief knowledge of botany and commercial utilization and uses of the following plants: Cereals and millets- Wheat, Rice and Maize, Ragi, Pearl millet. Sugar yielding plants- Sugarcane and Sugar beet. Fruits- Mango, Apple, Banana, Citrus and Litchi. Fibers- Cotton, Jute, Hemp, Coir, Agave and Semal. Vegetables- Root vegetables stem vegetables and fruit vegetables. Timbers- Teak, Shisham, Sal, Chir and Deodar.	15
3	Oils, Beverages, Fumitories, masticatories, Spices and Condiments Medicinal plants- <i>Aconitum</i> , <i>Atropa</i> , <i>Cinchona</i> , <i>Rauwolfia</i> , <i>Ephedra</i> , <i>Withania</i> , and <i>Alovera</i> . Bioprospects of medicinal plants.	15
4	Lesser known plants of Uttarakhand and their economic importance (Jhangora- Barnyard Millet, Koni- Foxtail millet, Jakhya, Bhangjeera, Tarur,) Wild edible plants of Uttarakhand: Kilmora, Hisalu, Ghigaru, Kafal, Timla, Bedu, Jamun, Lingura, Kachnar, Bichhu-Ghas.	15

	Conservation of traditional crops: Role of organizations (NBPGR, CIMAP, ICAR, VPKAS, GBPUAT)	
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Suggested readings

- Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
- Kochhar, S.L. (2016). Economic Botany: A comprehensive study, Fifth edition, Cambridge University Press, NY.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.
- Singh, H.B. and R.K. Arora. (1978). Wild edible plants of India (1st ed.). ICAR Publication, New Delhi.
- Wickens, G.E. (2004). Economic Botany: Principles and Practices, Springer, ISBN 978-0- 7923-6781-9.

Paper 3: Lab Course (Course code: BOT503P)

Credit: 2

Course outcomes

1. Know about the commercial products produced from plants.
2. Understand about the ethno-botanical details of plants.
3. Learn about the chemistry of plants and herbal preparations.

Unit	Topic	No. of Lectures (60 hrs)
1	Structure of prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs. Study of the photomicrographs of cell organelles, structure of plant cell through temporary mounts. Study of mitosis and meiosis (temporary mounts and permanent slides). Demonstration of the effect of temperature, organic solvent on semi permeable membrane. Study of plasmolysis, deplasmolysis, Endo- and Exo-osmosis.	15
2	Instruments and equipments 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.	15
3	Study of economically important plants: Cereals: Wheat, Rice, Maize Millets: Fingermillet, Foxtail, Ragi Pulses: Gram, Green gram, Pea, Pigeon pea, Soyabean, Chick pea Timbers: Shisam, Sal, Teak, Deodar, Pine	15