Mizoram University

UG/Bachelor's Degree Programme with Multiple Entry and Exit Options

Curriculum and Credit Framework for Undergraduate Programmes (CCFUP)
in
BOTANY

2023 (2025)

Undergraduate Botany
Course Structure and Credit Distribution

Semester	Course Code	Course Name	Credits
I	BOT100 (Major)	Phycology & Mycology	4
	BOT101 (Minor)	Economic Botany	4
		[Minor course from other disciplines]	4
	BOT110 (MDC)	Plants & Environment	3
	ENG/MIZ/HIN150	AEC:Language and Communication Skill	3
	VAC100	Value Added Course (Universal Human Values)	2
			20
II	BOT160 (Major)	Bryophytes & Pteridophytes	4
	BOT161 (Minor)	Plant Ecology & Environmental Biology	4
		[Minor course from other disciplines]	4
	BOT110 (MDC)	Plants & Environment	3
	SEC160	Skill Enhancement Course	3
	VAC120	Value Added Course (Understanding India)	2
			20
	UG Certificate in Botany		**40**
III	BOT200 (Major)	Genetics & Plant Breeding	4
	BOT201 (Minor)	Agroforestry, Palaeobotany & Palynology	4
		[Minor course from other disciplines]	4
	BOT110 (MDC)	Plants & Environment	3
	SEC270	Skill Enhancement Course	3
	VAC230/231	Value Added Course (Environmental Science/ Digital and Technological Solution)	2
			20
IV	BOT260 (Major)	Biochemistry & Cell Biology	4
	BOT261 (Minor)	Morphology & Embryology of Angiosperms	4
		[Minor course from other disciplines]	4
	ENG/MIZ/HIN250	AEC:Language and Communication Skill	3
	SEC280	Skill Enhancement Course	3
	VAC240/241/242	Value Added Course (Sports and Fitness/ Health and Wellness/ Yoga Education)	2
			20
	UG Diploma in Botany		**80**
V	BOT300 (Major)	Plant Anatomy & Gymnosperms	4
	BOT301 (Major)	Plant Systematics	4
	BOT302 (Minor)	Molecular Biology	4
		[Minor course from other disciplines]	4
	ENG/MIZ/HIN350	Language and Communication Skill	2
	IAF200	Internship / Apprenticeship/ Field Project	2
			20

VI	BOT360 (Major)	Microbiology & Plant Pathology	4
	BOT361 (Major)	Plant Biotechnology	4
	BOT362 (Major)	Plant Physiology	4
	BOT363 (Minor)	Bioinformatics & Biostatistics	4
		[Minor course from other disciplines]	4
			20
	UG Degree in Botany		**120**
VII	BOT400 (Major)	Biofertilizers	4
	BOT401 (Major)	Phytochemistry	4
	BOT402 (Minor)	Nursery & Gardening	4
		[Minor course from other disciplines]	4
		[Minor course from other disciplines]	4
			20
VIII	BOT460 (Major)	Aromatic Plants & their Products	4
	BOT461 (Major)	Plant Propagation & Tissue Culture	4
	RPD470	Research Project/Dissertation	12
			20
	Bachelor's degree/BSc in Botany (Honours with Research)		**160**
OR			
VIII	BOT460 (Major)	Aromatic Plants & their Products	4
	BOT461 (Major)	Plant Propagation & Tissue Culture	4
	BOT462 (Major)	Pomology	4
	BOT463 (Major)	Intellectual Property Rights	4
	BOT464 (Major)	Floriculture & Landscaping	4
			20
	Bachelor's degree/BSc in Botany (Honours)		**160**

Phycology & Mycology

BOT100 (Major)
Credit: 4

Unit I: Life histories of algae; Classification (by Fritsch); Algal cell structure; Range of thallus organization; Cell structure, reproduction and life cycles of *Nostoc*; Economic importance of algae.

Unit II: General characteristics of Chlorophyceae, Phaeophyceae and Rhodophyceae; Cell structure, reproduction and life cycles of *Chara, Ectocarpus* and *Polysiphonia*.

Unit III: General features of fungi; Classification of fungi (Ainsworth, 1973); General characteristics of Mastigomycota, Ascomycota, Basidiomycota and Deuteromycota; Cell structure, reproduction and life history of *Rhizopus* and *Agaricus*.

Unit IV: Introduction to mycorrhiza: Distribution, general characteristics, types and reproduction; Economic importance of fungi; Introduction to lichen: Distribution, general characteristics, types and reproduction and economic importance.

Suggested Readings:

1. Kumar, H.D.(1999). *Introductory Phycology*. Affiliated East- West Press Pvt. Ltd., New Delhi.
2. Lee, R.E.(2008). *Phycology*. 5th Ed. Cambridge University Press. USA.
3. Mukherjee, H. (1990). *Plant Groups*. New Central Book Agency, New Delhi.
4. Vashishta, B.R, Sinha, A.K and Kumar, A. (2016). *Botany for Degree Students: Mycology*. S. Chand and Company Pvt. Ltd., New Delhi.
5. Alexopoulos C. J., Mims C. W., and Blackwell M. (1996). *Introductory Mycology*, John Wiley, New York.
6. Deacon J.W. (1997). *Modern Mycology*, Blackwell Publishing.
7. Fritsch F. E. (1945). *The structure and reproduction of the algae Volume I & II*, Cambridge.
8. Graham J. E., Wilcox L. W., Graham L. E. (2008). *Biology of the Red Algae*. Benjamin Cummings.

Economic Botany

BOT101 (Minor)
Credit: 4

Theory

Unit I: Origin of Agriculture; Vavilov's centres of origin and diversity of crop plants; Germplasm augmentation and conservation; Plant quarantine; Natural rubber: tapping, processing, and uses.

Unit II: Morphology and uses of some selected crops: Cereals (rice, maize), pulses (pigeon pea, soyabean), legumes (winged bean, French bean); Morphology and processing of sugarcane and its products.

Unit III: Uses of spices (turmeric, ginger), Beverages (Tea and Coffee), oil seeds (groundnut, mustard), fibre-yielding plants (cotton, jute), timber-yielding (sal, teak).

Unit IV: Medicinal plants and their uses: roots (*Rauvolfia serpentina*), underground stem (*Allium sativum*), bark (*Cinchona* spp. & *Taxus* spp.), leaves (*Aloe* spp. & *Catharanthus roseus*), fruits (*Phyllanthus emblica* & *Carica papaya*), seeds (*Cuminum cyminum, Piper nigrum*).

Suggested Readings:

1. Any local/state/regional flora published by BSI or any other agency.
2. CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow (2016).
3. Kochhar, S.L. (2016). *Economic Botany: A Comprehensive Study*. 5th Edition. Cambridge
4. Samba Murty, AVSS and Subrahmanyam, N.S. (1989). *A textbook of Economic Botany*. Wiley Eastern Ltd., New Delhi
5. Sambamurty, AVSS and Subrahmanyam, N.S. (2008). *A Textbook of Modern Economic Botany*. CBS Publishers & Distributors Pvt.Ltd.; 1st edition (4 September 2008)
6. Wickens, G.E. (2001). *Economic Botany: Principles & Practices*. Kluwer Academic Publishers, The Netherlands.

Plants & Environment

BOT110 (MDC)
Credits: 3

Unit I: Ethno botany: Scope in India; Ethno botany with special reference to food (Rice, wheat), fruit (Indian gooseberry, papaya), fodder (Alfalfa, maize), fiber (Jute, cotton) and medicinal plants (Rauvolfia, Cinchona).

Unit II: Biodiversity: Definition and levels of biodiversity; Value of biodiversity; Biodiversity hotspots; Causes and consequences of biodiversity loss; Conservation of biodiversity – *in situ* and *ex situ*.

Unit III: Ecosystem – concept and components of an ecosystem; Environmental Pollution: Definition; Causes, effects and control of pollution (air, water, soil, noise).

Suggested Readings:

1. Odum, E.P. (2000). *Fundamentals of Ecology*. W.B. Saunders, Philadelphia.
2. Sharma, P.O. (2000). *Ecology and Environment*. 7th Edition, Rastogi Publication, Meerut.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2014). *Ecology, Environment Science and Conservation*. S. Chand & Co., Company Pvt. Ltd., New Delhi.
4. Hait, G, Bhattacharya, K., Ghosh A.K. (2020). *A Textbook of Botany Vol I & II*. New Central Book Agency, New Delhi.
5. Dutta, A.C. (2007). *Botany for Degree Students*. Revised 6th Edition, Oxford University Press, New Delhi.

Bryophytes & Pteridophytes

BOT160 (Major)
Credit: 4

Theory

Unit I: General characteristics of bryophytes; Classification of bryophytes up to order (Smith, 1955 and ICN system); General characteristics of Hepaticopsida, Anthocerotopsida and Bryopsida; Evolution of sporophytes.

Unit II: Alternation of generation; Thallus structure, reproduction and life history of *Marchantia, Anthoceros* and *Funaria*; Economic importance of bryophytes.

Unit III: General characteristics of Pteridophytes; Smith's system of classification (up to family); Morphology, reproduction and life history of *Selaginella* and *Pteris*.

Unit IV: Various types of steles; Heterospory and seed habit; Telome theory; Characters and distribution of *Adiantum* and *Azolla*; Economic importance of pteridophytes.

Suggested Readings:

1. Cavers, F. (1911). *The Interrelationship of Bryophytes*, Cambridge University Press.
2. Chopra R. N., Kumar P.K. (1988). *Biology of Bryophytes*, John Wiley & Co., New York.
3. Sporne K. R. (2012). *The Morphology of Pteridophytes*, Scientific Publishers, New Delhi.
4. Sunderajan S. (2009) Introduction to Pteridophytes, New Age International Publishers, New Delhi. University Press, U. K.
5. Hait, G, Bhattacharya, K., Ghosh A.K. (2020). *A Textbook of Botany Vol 1*. New Central Book Agency, New Delhi.

Plant Ecology & Environmental Biology

BOT161 (Minor)
Credit: 4

Theory

Unit I: Environments and environment factors; Population characteristics; Community characteristics: frequency, density, cover, life forms; Ecosystem structure (abiotic and biotic components, food chain, food web, ecological pyramids).

Unit II: Ecosystem function (energy flow); Biogeochemical cycles of nitrogen, carbon and phosphorus; Patterns of ecological succession; Impact of climate change on plants.

Unit III: Introduction to biological diversity; Levels of biodiversity; Biodiversity loss; ex-*situ* and *in-situ* conservation; Endemism; Hotspots; Effect of invasive alien plant species on biodiversity.

Unit IV: Renewable and non-renewable natural resources; Greenhouse effect; Acid rain; Ozone layer depletion; Photochemical smog; Non-biodegradable pollutants and biomagnification; Radioactive waste management.

Suggested Readings:

1. Ambasht R. S. and Ambasht, N. K. (2008). *Text Book of Plant Ecology (15th edn.)*.CBS Publishers and Distributers, New Delhi.
2. Kormondy, F.J.(1986). *Concept of Ecology*. Prentice Hall of India, New Delhi.
3. Odum, E.P. (2000). *Fundamentals of Ecology*. W.B. Saunders, Philadelphia.
4. Sharma, P.D. (2000). *Ecology & Environment, 7th Edition*, Rastogi Publications, Meerut.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2006). *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi, India.
6. Singh, J.S; Singh, S.P. and Gupta S.R. (2014). *Ecology, Environmental Science and Conservation*. S. Chand & Company Pvt. Ltd. New Delhi.

Genetics & Plant Breeding

BOT200 (Major)
Credit: 4

Theory

Unit I: Mendel's Laws of inheritance; non-Mendelian Inheritance (Plastid inheritance & cytoplasmic male sterility); Interaction of Genes: Intra- (Codominance, multiple alleles, incomplete dominance, lethal genes) and intergenic (Complementary, supplementary, duplicate, epistasis) interactions.

Unit II: Chromosome morphology and Karyotype concept; Structural aberrations (deletion, duplication, inversion & translocation) and numerical changes (euploidy & aneuploidy).

Unit III: Evolution of Gene Concept: Classical vs molecular concepts of gene; One gene-one character, One gene-one enzyme, one gene-one polypeptide hypothesis and beyond; Concept of sex determination and sex chromosomes in plants.

Unit IV: Principles of plant breeding; Pureline and mass selection; Techniques and procedure of hybridization; Heterosis; Theories of hybrid vigour; Significance of plant breeding in crop improvement; Mutation types; Physical and chemical mutagens.

Suggested Readings:

1. Acquaah, G. (2012). *Principle of plant genetics and breeding*. John Wiley and Sons Ltd, UK.
2. Allard, R.W. (1960). *Principles of plant breeding*. John Wiley and Sons, Inc., New York.
3. Chaudhary, R.C. (1993). *Introduction to plant breeding*. Oxford & IBH Publishing Co., New Delhi.
4. Harlt, D.L. and Jones, E.W. (2001). *Genetics: Principle and Analysis (4th edition)*. Jones and Bartlett Pub., USA.
5. Russel, P.J. (1998). *Genetics*. The Benjamin/Cummins Pub. Co., Inc. USA.
6. Snustad, D.P. and Simmons, M.J. (2000). *Principles of Genetics*. John Wiley and Sons, Inc., USA.

Practical

1. To study the general techniques in plant breeding, emasculation and bagging.
2. To work out the principle of Mendels law using punnett square.
3. To study the structure of chromosome (photograph).

Agroforestry, Palaeobotany & Palynology

BOT201 (Minor)
Credit: 4

Theory

Unit I: Agroforestry - definition, benefits and constraints of agroforestry; Shifting cultivation; Silviculture system; Homestead gardens; Alley cropping; Multipurpose trees in agroforestry system.

Unit II: Afforestation; Deforestation; Tree-crop interaction in agroforestry; Allelopathy and its impact on agroforestry; Canopy management: lopping, pruning, pollarding and hedging; Animal tree crop interaction.

Unit III: Palaeobotany: Definition and scope; Fossil formation; Types of fossils; Importance of fossil study; Geological time scale.

Unit IV: Palynology: Pollen morphology; Pollen wall structure; Dispersal of pollen grains; Role of pollen morphology in plant taxonomy; Pollen allergy; Importance of palynology in forensic science.

Suggested Readings:

1. Edan P. Collins (2014). *Agroforestry: A Practical Guide to Profitable Farms and Woodlands*. Nova science publishers.
2. J. Jansonius, Duncan Colin McGregor (1996). *Palynology: Principles and Applications*, American Association of Stratigraphic Palynologists Foundation.
3. K. Bhattacharya, M.R. Majumdar, S.G Bhattacharya (2011). *A Textbook of Palynology*, New Central Book Agency.
4. Louise E. Buck, James P. Lassoie, Erick C.M. Fernandes (1998). *Agroforestry in Sustainable Agricultural Systems*. CRC press.
5. Mayen, S.V. (1987). *Fundamentals of Palaeobotany*, Chapman and Hall, London.
6. Nair P.K.R, Kumar B.M and Nair V.D. (2021). *An Introduction to Agroforestry*. Kulwer Academic publishers.
7. Udawatta R.P and Jose S. (2021). *Handbook of Agroforestry*, Springer.
8. Bhattacharya, K., Majumdar, M.R, Bhattacharya, S.G. (2006). *A textbook of Palynology*. New Central Book Agency (P) Ltd. Kolkata.

Biochemistry & Cell Biology

BOT260 (Major)
Credit: 4

Theory

Unit I: Structure and classification of carbohydrates (monosaccharides, disaccharides, oligosaccharides and polysaccharides), amino acids and proteins.

Unit II: Classification and nomenclature of enzymes; Composition, structure and function of different types of nucleic acids; Structure of ATP.

Unit III: Overview of Cell: structure & types (Prokaryotes & Eukaryotes); The cell membrane: composition, structure and functions; The nucleus: structural components; Cell cycle and cell division (Mitosis & Meiosis); Linkage & Crossing over.

Unit IV: Cytoskeletal elements: role and structure in plant cells; Structural organization and function of cell organelles: mitochondria, ribosome, endoplasmic reticulum, golgi apparatus and plastids.

Suggested Readings:

1. Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P (2002). *Molecular Biology of the Cell, 4th Edition*, Garland Science, New York & London.
2. Karp G. (2008). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.
3. Gupta P, K, (2005). *Cytology Genetics and Evolution.* Rastogi Publications.
4. Lewin's GENES XII (2017). Jocelyn E. Krebs (Author), Elliott S. Goldstein (Author), Stephen T. Kilpatrick.
5. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008). *Molecular Cell Biology.* WH Freeman & Co., New York.

Practical

1. Separation of amino acid by paper chromatography.
2. Estimation of proteins by Lowry’s method.
3. Study of mitosis in onion root tip.

Morphology & Embryology of Angiosperms

BOT261 (Minor)
Credit: 4

Theory

Unit I: Morphological characteristics of angiosperms: vegetative (root, stem, leaf) and floral (calyx, corolla, androecium, gynoecium, fruit).

Unit II: Pollination: definition, types of pollination, agents for cross-pollination; Sexual incompatibility: Self- incompatibility; Barrier to fertilization; Biological significance of incompatibility; Methods to overcome incompatibility.

Unit III: Fertilization: entry of pollen tube (chalazogamy, mesogamy, porogamy), double fertilization and triple fusion, significance of double fertilization; Parthenocarpy; Polyembryony; Apomixis.

Unit IV: General account of microsporangium and microsporogenesis, megasporangium and megasporogenesis; Male and female gametophyte; Monocot and dicot embryo; Types of endosperms (nuclear, cellular & helobial).

Suggested Readings:

1. Beck, C (2010). *An Introduction to Plant Structure and Development*.
2. Bhojwani, S.S. and Bhatnagar, S.D.(2004). *The Embryology of Angiosperms*. Vikas Publishing House, New Delhi.
3. Haberlandt, G. (1914). *Physiological Plant Anatomy*.
4. Howell S. P (1998). *Molecular Genetics of Plant Development*, Cambridge University Press.
5. Raghavan, V. (2000). *Developmental Biology of Flowering Plants*, Springer.

Plant Anatomy & Gymnosperms

BOT300 (Major)
Credit: 4

Theory

Unit I: Internal organization of plant body: types of cells and tissues; Classification of tissues: simple and complex tissues; Tissue system; Anatomy of dicot and monocot stem; Anatomy of isobilateral and dorsiventral leaf.

Unit II: Cambium activity and Secondary growth in stem, root; Anomalous secondary growth in *Mirabilis, Bignonia* and *Dracaena*; Root-stem-transition; Anatomical adaptations in hydrophytes and xerophytes.

Unit III: Classification and general characteristics of gymnosperms; General account of morphology and reproduction of the following: *Cycas, Pinus* and *Gnetum.*

Unit IV: Distribution of living gymnosperms in India; phylogenetic trend in gymnosperms; Economic importance of gymnosperms; Structure and evolution of ovule; General account of archegonia (without development).

Suggested Readings:

1. A.J. and MacDaniels, L.H. (1947). *An Introduction to Plant Anatomy*.
2. Carlquist, S. (1961). *Comparative Plant Anatomy*.
3. Esau, K (1991). *Plant Anatomy*. Wiley Eastern University Ed.
4. Roy, P. (2010). *Plant Anatomy*. New Central Book Agency (P) ltd. Kolkatta.
5. Fahn, A. (1990). *Plant Anatomy (4 th Edition)*.
6. Haberlandt, G. (1914). *Physiological Plant Anatomy*.
7. Vasistha,P.C.(1996). *Botany for Degree Students Vol V (Gymnosperms).* S. Chand & Co. Ltd. New Delhi.

Practical

1. Anatomical study of
   a. stem,
   b. root,
   c. leaf (Primary structure)
2. Anatomical study of anomalous growth in *Mirabilis/ Dracaena.*
3. Study of morphology and reproductive structure of *Pinus/ Gnetum.*

Plant Systematics

BOT301 (Major)
Credit: 4

Theory

Unit I: Origin of Angiosperms; Classification of angiosperms with reference to the system of Linnaeus, Bentham & Hooker and Engler & Prantl; Chemotaxonomy; Numerical taxonomy.

Unit II: Taxonomy Vs Systematics; Concept of species and hierarchical taxa; Principles and rules of ICN (formerly ICBN): ranks and names; typification, author citation, valid publication, rejection of names; Angiosperm Phylogeny Group (APG) System.

Unit III: Herbarium preparation and management; Functions of herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium.

Unit IV: Diagnostic features and economic importance of Brassicaceae, Asteraceae, Solanaceae, Orchidaceae and Poaceae.

Suggested Readings:

1. Bhojwani,S.S. and Bhatnagar,S.D. (2004). *The Embryology of Angiosperms*. Vikas Publishing House, New Delhi.
2. Simpson, Micheal. G. (2011). *Plant Systematics*. Elsevier, Academic Press.
3. Singh, Gurucharan. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH, New Delhi.
4. Singh,V. and Jain,D.K. (2010). *Taxonomy of Angiosperms*. Rastogi Publications, Meerut.
5. Taik,V.N (1984). *Taxonomy of Angiosperms*. Tata Mc Graw Hill Pub.Co. Ltd. New Delhi.
6. Vasistha,B.R.(1998). *Economic Botany*. S. Chand & Co. Ltd. New Delhi.

Practical

1. Preparation of herbarium.
2. Taxonomic studies of angiospermic plants belonging to families mentioned in Unit IV.

Molecular Biology

BOT302 (Minor)
Credit: 4

Theory

Unit I: DNA Structure: Chemical composition and structure of DNA, salient features of the double helix; Types of DNA; Organization of DNA - Prokaryotes: Circular DNA, nucleoid structure. Eukaryotes: Linear DNA, chromatin, nucleosomes, and higher-order organization.

Unit II: DNA Replication - Models of DNA replication: Semiconservative, conservative, and dispersive models; Mechanism of replication: Initiation, elongation, and termination; Enzymes involved in replication**.**

Unit III: Types of RNA: Messenger RNA (mRNA), Transfer RNA (tRNA), Ribosomal RNA (rRNA) and other non-coding RNAs (snRNA, miRNA); Structure of RNA: Single-stranded nature, secondary structures (hairpins, loops); Functions of RNA: Role in gene expression and protein synthesis.

Unit IV: Mechanism of transcription in prokaryotes: Initiation: Role of promoters, sigma factor, and RNA polymerase. Regulation of Transcription: Operon model (lac operon); The Central Dogma: Flow of genetic information from DNA to RNA to protein; Genetic Code.

Suggested Readings:

1. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P (2002). *Molecular Biology of the Cell 4thEdition*, Garland Science, New York & London
2. Brown, T (2018). *Genomes 4*, Garland Science, New York
3. Buchanan, B.B., Gruissem, W. and Jones, R.L (2015). *Biochemistry and molecular biology of plants*. John Wiley and Sons Ltd., UK.]
4. Karp, G (2010). *Cell and Molecular Biology: Concepts and experiments. 6th Edition*. John Wiley & Sons. Inc.
5. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008). *Molecular Cell Biology*. WH Freeman & Co., New York.

Microbiology & Plant Pathology

BOT360 (Major)

Credit: 4

Unit I: History and scope of microbiology; Classification of bacteria (morphological, nutritional); Structure of a bacterial cell; An account on genetic recombination in bacteria (transformation, conjugation, transduction).

Unit II: Applied microbiology: biofertilizer, fermentation; Microbial bioremediation; Antibiotics; Economic importance of bacteria and fungi.

Unit III: History and scope of plant pathology; Transmission and spread of pathogens; General characteristics of virus; Classification of virus (Baltimore); Structure of bacteriophages; Lysogenic and lytic cycles.

Unit IV Infection and host-pathogen interactions; Pathogenesis; Plant defense mechanism: pre-existing (structural and chemical), post infection (structural and chemical); Study of common plant disease (blast of rice, soft rot of ginger).

Suggested Readings:

1. Agrios G. N. (2005). *Plant Pathology*. Elsevier, Amsterdam.
2. Pezczar M. J. (1977). *Microbiology*, Tata McGraw Hill, New Delhi.
3. Prescot L. M. (2005). *Microbiology*, McGraw Hill, Boston.
4. Sharma, P.D. (2007). *Microbiology and Plant Pathology*. Rastogi Publications. Meerut. India.

Practical

1. Demonstration of gram staining of bacteria.
2. Preparation of common culture media (PDA/ nutrient agar).
3. Study of disease specimens prescribed in theory papers by temporary preparations and with the help of permanent slides.

Plant Biotechnology

BOT361 (Major)
Credit: 4

Theory

Unit I: Introduction to plant tissue culture: Nutrient media, Sterilization, Totipotency; Plant tissue culture techniques (Protoplast, meristem and embryo culture); Artificial seeds; Cryopreservation.

Unit II: Introduction to genetic engineering: Enzymes used in genetic engineering (Restriction enzymes, Ligase); Cloning vectors; Selectable markers and reporter genes; Basics of PCR.

Unit III: Agrobacterium mediated gene transfer; Direct gene transfer methods (Electroporation, Microinjection, Microprojectile bombardment); Biosafety and ethical concerns with transgenic technology.

Unit IV: Transgenic plants: Pest resistant (Bt-cotton); Herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Plant biotechnology in agriculture.

Suggested Readings:

1. Bojwani, S.S. (1990). *Plant tissue culture: Application and limitation*. Elsevier, Amsterdam.
2. Dubey, R.C. (1996). *Textbook of biotechnology*. S Chand and Comp. New Delhi.
3. Gupta, P.K. (2004). *Biotechnology and Genomics*. Rastogi Publications, New Delhi.
4. Kumar, (2000). *Modern concept of biotechnology*. Vikas Publishing House Pvt. Ltd. New Delhi.
5. Slater, A., Scott, N.W and Fowler, M.R. (2008). *Plant Biotechnology*. Oxford University Press, UK.
6. Smith, R. (2000). *Plant tissue culture techniques. 2nd edition*. Academic Pvt.

Practical

1. Study of tissue culture techniques. Preparation of media MS (1962) Nistch (1969).
2. Study of genetic engineering techniques (photographs).
3. Demonstration of Southern, Northern and Western blotting.
4. Study of steps of genetic engineering techniques from photographs (Bt cotton, golden rice).

Plant Physiology

BOT362 (Major)
Credit: 4

Theory

Unit I: Water potential, water absorption, loss of water and mechanism of stomatal transpiration; Mineral nutrition (macro and micro); deficiency symptoms (N,P,K); Uptake and translocation of solutes.

Unit II: Photosynthesis: Light reaction (Radiant energy, photosynthetic apparatus, Photolysis, light harvesting complex, photosystems, photosynthetic electron transport); Dark reaction: Carbon dioxide fixation in C3 and C4.

Unit III: Photorespiration; Glycolysis, preparatory and pay-off phases; Kreb's cycle; Electron transport chain and oxidative phosphorylation.

Unit IV: Physiological roles of plant hormones: Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene; Synthetic growth regulators: Classification, their effect on plant growth and development; Stress and hormones with special reference to Abscisic Acid.

Suggested Readings:

1. Bonner, J. and Varner, J.E. (1976). *Plant biochemistry*. Academic press New York.
2. Devlin, R.N. (1969). *Plant Physiology*. Affiliated East West, New Delhi.
3. Dutta, S.C. (1989). *Plant physiology*. Central Book Depot, Allahabad.
4. Jellinck, P.H.(1991). *Biochemistry*. Holt, Rinechard & Winston Ltd. Canada.
5. Nelson, D.L. and Cox, M. (2017). *Lehninger Principles of Biochemistry*, WH Freeman & Co. New York
6. Tiaz, L. and Zeiger, E. (2006). *Plant physiology. 4th Edition*. Sinauer Associates Inc.

Practical

1. To determine the osmotic potential of cell sap by the plasmolytic method.
2. Estimation of Respiratory Quotient (RQ) by Ganong's respirometer.
3. Extraction and separation of plant pigments by paper chromatography.
4. Study of transpiration rate in dorsiventral leaves by Garreau's potometer.
5. Estimation of chlorophyll content of leaf by spectrophotometric method

Bioinformatics & Biostatistics

BOT363 (Minor)
Credit: 4

Theory

Unit I: Introduction to bioinformatics; Branches of bioinformatics; Biological databases for DNA and proteins; Classification of databases (primary, secondary and composite databases).

Unit II: Introduction to database search tools (FASTA, BLAST, Clustal W); Standard variants of BLAST program; Sequence alignment (pair wise and multiple sequence alignment); Phylogenetic tree construction (Maximum Parsimony Method).

Unit III: Measures of central tendency (Arithmetic Mean, Median, Mode). Measures of dispersion (Standard deviation and standard error), ANOVA, Correlation; regression.

Units IV: Hypothesis: null and alternate hypothesis and testing of hypothesis, Student t-test; Chi-square test. Types of data, method of collection, methods of data presentation (line, bar diagram, pie diagram, pictogram and cartogram).

Suggested Readings:

1. Banerjee P.K. (2004). *Introduction to biostatistics*, S Chand and Company limited. New Delhi.
2. Baxevanis, A. D. and Ouellette, B. F. F. (2005). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. John Wiley and Son Inc., USA.
3. Bliss, C.I.K. (1967). *Statistics in biology, Vol. 1*, McGraw Hill, NewYork
4. Campbell, R.C. (1974). *Statistics for Biologist,* Cambridge University Press, UK.
5. Chandel R S (1975). *A handbook of Agricultural statistics*. AchalprakashanMandir.
6. Mount, D. W. (2004). *Bioinformatics Sequence and Genome Analysis*. CSHL Press, USA.
7. Tramontano, A. (2007). *Introduction to Bioinformatics*. Chapman & Hall/CRC, USA.

Biofertilizers

BOT400 (Major)
Credit: 4

Theory

Unit I: General account of microbes used as biofertilizers; *Rhizobium*: morphology, identification, isolation, cultivation and mass multiplication; *Azospirillum*: isolation and mass multiplication; *Azotobacter*: classification, characteristics, crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Unit II: Cyanobacteria: Symbiotic association of blue green algae; *Azolla* and *Anabaena azollae* association, nitrogen fixation, blue green algae and *Azolla* in rice cultivation.

Unit III: Mycorrhizal association; Types of mycorrhizal association, occurrence and distribution; colonization, isolation and inoculum production of VAM; Influence of VAM on growth and yield of crop plants.

Unit IV: Organic farming: Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes; Biocompost making methods, types and method of vermicomposting.

Suggested Readings:

1. Dubey R.C. (2005). *A Text book of Biotechnology*. S.Chand & Co, New Delhi.
2. John Jothi Prakash E. (2004). *Outlines of Plant Biotechnology*. Emkay Publication, New Delhi.
3. Kumaresan V. (2005). *Biotechnology*, Saras Publications, New Delhi.
4. NIIR Board. (2012). *The complete Technology Book on Biofertilizer and organic farming. 2nd Edition*. NIIR Project Consultancy Services.
5. Sathe T.V. (2004). *Vermiculture and Organic Farming*. Daya publishers.
6. Subba Rao N.S. (2017). *Biofertilizers in Agriculture and Forestry. Fourth Edition*. Medtech.
7. Vayas S.C, Vayas S. and Modi H.A. (1998). *Bio-fertilizers and organic Farming*. Akta Prakashan, Nadiad.

Practical

Based on theory BOT400

Phytochemistry

BOT401 (Major)
Credit: 4

Theory

Unit I: Introduction to phytochemistry: Definition and scope; Primary and secondary metabolism; Collection of sample, identification and drying, Cold and hot solvent extraction (Soxhlet and otherwise) for analysis purpose; Extract concentration (Rotary evaporation/ air drying).

Unit II: Solvent selection for specific phychemicals (polar & non-polar solvents – hexane, chloroform, isopropanol, butanol, methanol, water); Fractionation and purification of isolated compounds: Alkaloids (caffeine, atropine), Terpenoids (menthol), Steroids (diosgenin), Flavonoids & Phenolics (β carotene, curcumin, quercetin), Glycosides (glycerrhizin), Polyphenols (tannins).

Unit III: Phytochemical analysis: Chormatography – TLC, HPLC, GC and their applications; Spectroscopy – uv-vis, IR and mass Spectrometry (uses and applications); Nuclear Magnetic Resonance.

Unit IV: Application of phytochemistry: Phytomedicine, Drug development, Food Science, Industrial Applications; Quality Control of Phytomedicines.

Suggested Readings:

1. Harborne. J.B. (1998). *Phytochemical methods. A guide to modern techniques of Plant Analysis*. Chapman and Hall publication, London
2. Plumber, D. T. (2006). *An introduction to practical biochemistry*. TATA-McGrawHill Publication, New Delhi
3. Shah, B.N. (2005). *Text book of Pharmacognosy and Phytochemistry*. Cbs Publishers & Distributors-New Delhi
4. Egbuna, C., Chinenye, J. Stanley I. and Udedi, C. (2018). *Phytochemistry: Fundamental, modern techniques and applications*. Apple Academic Press. CRC press.

Practical
Based on theory BOT401

Nursery & Gardening

BOT402 (Minor)
Credit: 4

Theory

Unit I: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities; Planting – direct seeding and transplants.

Unit II: 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.

Unit III: 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 glasshouse.

Unit IV: Gardening: definition, objectives and scope; different types of gardening, landscape and home gardening; Parks and its components; Gardening operations: soil laying, manuring, watering, management of pests and diseases in gardening.

Suggested Readings:

1. Bose T.K. & Mukherjee, D. (1972). *Gardening in India*, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K. (1989). *Plant Propagation*, Wile Eastern Ltd., Bengaluru.
3. Kumar, N. (1997). *Introduction to Horticulture*, Rajalakshmi Publications, Nagercoil.
4. Edmond J.B., Musser A.M. & Andrews F.S. (1957). *Fundamentals of Horticulture*, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. (1993). *Handbook of Seed Technology,* Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules (1979). *Horticultural Science. (3rd Ed.)*, W.H. Freeman and Co., San Francisco, USA.

Aromatic Plants & their Products

BOT460 (Major)
Credit: 4

Theory

Unit I: Introduction to Medicinal Plants; Medicinal Plants: past and present status in world and India; Medicinal plant diversity & local healthcare; Medicinal plant conservation: issues and approaches.

Unit II: Promotion of the medicinal plant sector at the national level: National Medicinal Plant board and State Medicinal Plant Boards: objectives and functions; Demand and supply of medicinal plants; Herbal Industries.

Unit III: Important medicinal plants of India with their systematics. Geographical distribution and uses *–Adhatoda vasica, Withania somnifera, Clerodendrum colebrookianum, Picria fel-terrea, Acmella oleracea.*

Unit IV: Introduction and historical background of aromatic plants; Aromatic and cosmetic products; Raw materials for perfume; Cosmetic industries; Major, minor and less-known aromatic plants of India; Taxonomic description and uses of important aromatic plants (large cardamom, cinnamon, cloves, cumin, coriander).

Suggested Readings:

1. Ákos Máthé, A (2015). *Medicinal and Aromatic Plants of the World: Scientific, Production, Commercial and Utilization Aspects (Medicinal and Aromatic Plants of the World, 1)*, Springer Publication
2. EIRI Board (2009). *Hand Book Of Medicinal & Aromatic Plants*. Engineers India Research Ins. New Delhi.
3. Koedam, A, Margaris, M.S. and Vokou, D. (2011). *Aromatic Plants: Basic and Applied Aspects: 7 (World Crops: Production, Utilization and Description, 7)*, Springer Publication.
4. *Medicinal and Aromatic Plants (Book series) - Industrial Profiles*. Routledge Homes, Taylor and Francis.

Practical

Based on theory BOT460

Plant Propagation & Tissue Culture

BOT461 (Major)
Credit: 4

Theory

Unit I: Biology of Plant Propagation: Propagation environment, Preparation of soil and other (soil free) media, Hydroponic propagation

Unit II: Propagation through Seeds: Sowing techniques, Seed selection, seed testing, viability testing and breaking the seed dormancy, seed production and handling, seed storage and conservation of seed.

Unit III: Macropropagation: Vegetative Propagation through stem cutting, layering, budding, grafting; Propagation by specialized stems and roots.

Unit IV: Micropropagation: Concept of plant tissue culture; Preparation of stock solution and nutrient media (MS media); Media sterilization; Totipotency; Plant growth regulators (PGRs); Somatic embryogenesis.

Suggested Readings:

1. Lewis, Hill. (1985). *Secrets of Plant Propagation*. American Horticultural Society. Storey Books,
2. Dirr, M.A. (2009). *Manual of Woody Landscape Plants. (6th ed)* Champsign, Il: Stipes Pub.
3. Kock, H., Arid, Paul., Ambrose, J. and Waldron G. (2008). *Growing Trees from Seeds*. Richmomd Hill : Firefly Books Publ.
4. Toogood, A. R. (1999). *Plant Propagation*. American Horticultural Society Practical Guides. DK Publ, pp 320.
5. Hartmann, H.I. and Kester, O.T. (2015). *Plant Propagation: Principles and Practices*. 8th Edition. Pearsons.
6. Sadhu, M. K. (1994). Plant Propagation. First edition .John Wiley & Sons. 7. Phillips, Harry R. (1995). Growing and Propagating wild Flowers. The University of North Carolina Press,

Practical

Based on theory BOT461

Pomology

BOT462 (Major)
Credit: 4

Theory

Unit I: Definition, scope and importance of pomology, role of fruits in human nutrition. Major groups of fruit crops of local climates/regions, (a) deciduous (stonefruits, pomefruits) and (b) evergreen (e.g. olive, citrus species) fruit crops.

Unit II: Specific requirements for cultivation (soil management, fertilization, pruning, thinning, irrigation); Propagation (rootstocks), Harvesting.

Unit III: Registration procedure with new cultivars, Botanical classification of cultivars; Planning and layout of orchards, preparation of land for orchard development, selection of planting materials and transplanting, protection of young plants.

Unit IV: Fruit preservation, present status, future prospecting nutritive value of fresh and processed fruits, Brief account on principles and methods of refrigeration, canning dehydration and chemical preservation.

Suggested Readings:

1. NIIR Board. (2005). *Cultivation of Fruits, Vegetables and Floriculture*. National Institute of Industrial Research, New Delhi.
2. Gourley, J H, (2009). *Text-Book of Pomology*. Laing Press,
3. Chattopadhyay, T.K. (2015). *A textbook on Pomology Devoted to Temperate*, Kalyani Publishers.
4. Chattopadhyaya, T.K. (2014) *A Textbook on Pomology (Fundamental, Vol-I)*, Kalyani Publishers., New Delhi.

Practical

1. Field trips: Field visit to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at agricultural institutes / universities or other suitable locations.
2. Identification of major conditions responsible for spoilage of horticultural crops.
3. Identification of pathogenic and non-pathogenic diseases of horticultural plants.
4. More Practical may be added depending on the local habitats and available facilities.

Intellectual Property Rights

BOT463 (Major)
Credit: 4

Theory

Unit I: Introduction to Intellectual Property Rights (IPR); Types of intellectual property; Importance of IPR; Evolution of IP acts and treaties; Agencies responsible for IPR registrations.

Unit II: Trademarks: Purpose and function of trademarks, acquisition of trademark rights, transfer of rights, registration of trademarks, claims; Trade Secrets: Trade secret law, determination of trade secret status, liability for misappropriation of trade secrets, trade secret litigation; Geographical Indication: Basic aspects and need for the registration.

Unit III: Copyrights: Fundamentals of copyright law, originality of material, right of reproduction, right to perform the work publicly, copyright ownership issues, notice of copyright; Patent: Foundation of patent law, patent searching process, Basic Criteria of Patentability; Industrial Designs: Kind of protection provided in Industrial design.

Unit IV: Introduction to Cyber Law: Information Technology Act, cyber crime and e-commerce, data security, confidentiality, privacy, international aspects of computer and online crime.

Suggested Readings

1. David Kitchin Q.C., Llewelyn, D., Mellor, J., Meade, R., Thomas Moody-Stuart, and D. Gopalakrishnan, N.S. and Agitha, T.G. (2009). *Principles of Intellectual Property.* Eastern Book Company, Lucknow.
2. Keeling, Jacob, R. (2005). *Kerly's Law of Trade Marks and Trade Names (14th Edition).* Thomson, Sweet & Maxweel.
3. Narayanan, P. (2010). *Law of Copyright and Industrial Designs,* Eastern law House, Delhi.
4. Parulekar, A. and D' Souza, S. (2006). *Indian Patents Law – Legal & Business Implications*, Macmillan India Ltd.
5. Wadehra, B.L. (2000). *Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications*, Universal law Publishing Pvt. Ltd., India.

Practical: There are no experimental lab based Practical. However, the students are expected to prepare some project report based on the Success stories of Traditional Patents secured by India. Likewise, prepare a database for Indian products wherein is issue is still under consideration of the competent authorities. Prepare the dos and don'ts on Patents for Botanists.

Floriculture and Landscaping

BOT464 (Major)
Credit: 4

Theory

Unit I: History of gardening; Importance and scope of floriculture; Nursery: Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary.

Unit II: Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and fern allies; Cultivation of plants in pots; Indoor gardening; Bonsai. Principles of Garden Designs: English and Japanese gardens; Some Famous gardens of India.

Unit III: Landscaping places of public importance: Landscaping highways and Educational institutions; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden).

Unit IV: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Anthurium, Chrysanthemum, Rose, Orchids); Diseases and Pests of Ornamental Plants.

Suggested Readings:

1. Randhawa, G.S. and Mukhopadhyay, A. (1986). *Floriculture in India*. Allied Publishers.
2. Adams, C., M. Early and J. Brrok (2011). *Principles of Horticulture.* Routledge, U.K.
3. Roy A Larson A, R. (1992). *Introduction to Floriculture*, Academic Press, Cambridge, Massachusetts.
4. S. K. Datta, S,L, Gupta, C, Y, (2022). *Handbooks of Crop Diversity: Conservation and Use of Plant Genetic Resources*, Floriculture and Ornamental Plants, Springer.

Practical

Based on theory BOT464