Mizoram University

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

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

2023

Undergraduate Botany
Course Structure and Credit Distribution

Semester	Course Code	Course Name	Credits
I	BOT/MJ/100	Phycology and Mycology	4
	BOT/MJ/101	Economic Botany	4
		[Minor course from other disciplines]	4
	MC/BIO/102	Fundamentals of Biology	3
		Language and Communication Skill	3
		Value Added Course	2
			20
II	BOT/MJ/103	Biochemistry and Cell Biology	4
	BOT/MJ/104	Plant Ecology & Environmental Biology	4
		[Minor course from other disciplines]	4
	MC/BIO/102	Fundamentals of Biology	3
		Skill Enhancement Course	3
		Value Added Course	2
			20
	UG Certificate in Botany		**40**
III	BOT /MJ/200	Plant Breeding & Genetics	4
	BOT /MJ/201	Agroforestry, Paleobotany & Palynology	4
		[Minor course from other disciplines]	4
	MC/BIO/102	Fundamentals of Biology	3
		Skill Enhancement Course	3
		Value Added Course	2
			20
IV	BOT /MJ/203	Embryology of Angiosperms	4
	BOT /MJ/204	(Bryophytes and Pteridophytes	4
		[Minor course from other disciplines]	4
		Language and Communication Skill	3
		Skill Enhancement Course	3
		Value Added Course	2
			20
	UG Diploma in Botany		**80**
V	BOT /MJ/300	Plant Anatomy	4
	BOT /MJ/301	Phanerogams & Plant systematics	4
	BOT /MJ/302	Plant Physiology	4
		[Minor course from other disciplines]	4
		Language and Communication Skill	2
		Internship	2
			20
VI	BOT /MJ/303	Microbiology and Pathology	4

	BOT /MJ/304	Plant Biotechnology	4
	BOT /MJ/305	Molecular Biology	4
	BOT /MJ/306	Bioinformatics & Biostatistics	4
		[Minor course from other disciplines]	4
			20
	UG Degree in Botany		**120**
VII	BOT /MJ/400	Biofertilizers	4
	BOT /MJ/401	Floriculture	4
	BOT /MJ/402	Phytochemistry	4
		[Minor course from other disciplines]	4
		[Minor course from other disciplines]	4
			20
VIII	BOT /MJ/403	Aromatic Plant & their Products	4
	BOT /MJ/404	Plant Propagation & Tissue Culture	4
	BOT /RP/499	Research Project/Dissertation	12
			20
	Bachelor's degree/BSc in Botany (Honours with Research)		**160**
OR			
VIII	BOT /MJ/403	Aromatic Plant & their Products	4
	BOT /MJ/404	Plant Propagation & Tissue Culture	4
	BOT /MJ/405	Pomology	4
	BOT /MJ/406	Intellectual Property Rights	4
	BOT /MJ/407	Nursery & Gardening	4
			20
	Bachelor's degree/BSc in Botany (Honours)		**160**

Phycology and Mycology

BOT/MJ/100

Unit I : Life histories of algae ; Classification (by Fritsch) ; Algal cell structure; Algal bioprospecting; Range of thallus organization, Cell structure, Reproduction and Life Cycles of *Nostoc, Spirullina* .

Unit II : General characteristics of Chlorophyta, Phaeophyta and Rhodophyta; Ecology and occurrence, Range of thallus organization , Cell structure, Reproduction and life cycles of *Chara, Ectocarpus* and *Polysiphonia*. Economic importance of algae.

Unit III : General features of fungi; Classification of fungi; General characteristics of Mastigomycotina, Ascomycotina, Basidiomycotina and Deuteromycetes. Cell structure and reproduction and life history of *Agaricus, Alternaria*

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. Aff. East- West Press Pvt.Ltd. New Delhi
2. Lee.R.E.(2008). Phycology.5th Ed. Cambridge University Press. USA.
3. Hait, G, Bhattacharya, K., Ghosh A.K. (2020). A Textbook of Botany Vol 1. New Central Book Agency, New Delhi
4. Mukherjee, H. (1990) Plant Groups. New Central Book Agency, New Delhi.
5. Vashishta, B.R, Sinha, A.K and Kumar, A. (2016). Botany for Degree Students: Mycology.S.Chand and Company pvt ltd. New Delhi.
6. Alexopoulos C. J., Mims C. W., Blackwell M. (1996) Introductory Mycology, John Wiley, New York.
7. Deacon J.W. (1997) Modern Mycology, Blackwell Publishing.

Economic Botany

BOT/MJ/101
Credit: 4

Theory

Unit I: Origin of Agriculture and ancient economic botany; Vavilov's Centres of Origin and diversity of crop plants; Germplasm augmentation and conservation; Plant Quarantine; Natural Rubber: Para 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, products, and by-products.

Unit III: Botanical name, family, and part used of spices (Turmeric, Ginger), Beverages (Tea and Coffee), Oil seeds (groundnut, mustard), fibre-yielding plants (Cotton, jute), timber-yielding (Sal, teak)

Unit IV: Drugs obtained from- roots (*Elaegnus latifolia*), underground stem (*Curcuma longa*), bark (*Cinchona* spp.), leaves (*Aloe* spp.), fruits (*Papaver somniferum*); Antibiotics.

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. 1st Edition, Paperback. CBS Publishers & Distributors Pvt.Ltd.; 1st edition (4 September 2008)
6. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

Fundamentals of Biology

MC/BIO/102
Credits: 3

Unit 1: Contributions of Aristotle in biology. Development of physiology from Galen to William Harvey. Germ theory of diseases: works of Girolamo Fracastoro, Louis Pasteur and Robert Koch. Origin of evolutionary theories: Lamarckism and natural selection.

Unit 2: Discovery of cell: contributions of Robert Hooke and Antonie van Leeuwenhoek. Origin of cell theory: Matthias Schleiden, Theodor Schwann and Rudolf Virchow. Birth of genetics: Mendel's experiments and laws.

Unit 3: Discovery of antibiotics: Salvarsan, Prontosil (sulfonamide), penicillin, and streptomycin. Discoveries of DNA as a genetic material and the helical structure. Development of the Human Genome Project. Cloning – Dolly, and ethical issues.

Suggested Readings

1. Lutz, P. L. (2002). *The Rise of Experimental Biology: An Illustrated History*. Springer.
2. Magner, L. N. (2002). *A History of the Life Sciences*. CRC Press.
3. Olby, R. C. (1994). *The Path to the Double Helix: the Discovery of DNA*. Dover Publications Inc.
4. Rosen, W. (2018). *Miracle Cure: The Creation of Antibiotics and the Birth of Modern Medicine*. Penguin.
5. Serafini, A. (2013). *The Epic History of Biology*. Springer.

Biochemistry and Cell Biology

BOT/MJ/103
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, function, types, origin theory. The cell membrane: composition, structure and functions. The nucleus: structural components. Cell cycle and cell division

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 4thEdition, Garland Science, New York & London 2. Cell and Molecular Biology: Concepts and Experiments (2008). Karp G. 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.

Plant Ecology & Environmental Biology

BOT/MJ/104
Credit: 4

Theory

Unit I: Environments and environment factors; Population characteristics: ecotypes and ecads; 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 carbon and phosphorus); Ecological succession: types and pattern. Global Change Ecology: plant responses to anthropogenic global change, including climate change, land-use change, and biological invasions.

Unit III: introduction to biological diversity indices (Shannons, Shimson dominance index); Biodiversity loss and ex-situ and in-situ conservation; Endemism; Hotspots; Phytogeographical division of India.

Unit IV: Concept of biosphere; Renewable and Nonrenewable natural resources; Conservation of soil and water 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. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
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

BOT/MJ/200
Credit: 4

Theory

Unit I: Mendel's Laws of inheritance & non-Mendelian Inheritance; Interaction of Genes: Intragenic and intergenic interactions; Linkage and crossing over, Cytological basis of crossing over; Linkage and Gene mapping.

Unit II: Chromosome morphology and Karyotype concept; Chromosome: Structural aberrations and numerical changes; Types of mutations, physical and chemical mutagens.

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;

Unit IV: Principles of Plant Breeding; Pureline and mass selection; Techniques and procedure of hybridization; Heterosis; Theories of hybrid vigour. Significance Plant breeding in crop improvement

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. Karyotyping a given set of chromosomes.

Agroforestry, Palaeobotany & Palynology

BOT/MJ/201
Credit: 4

Theory

Unit I: Agroforestry - definition, aims, objectives; benefits and constraints of agroforestry; Overview of global agroforestry system - shifting cultivation, silviculture system; homestead gardens; alley cropping; multipurpose tree species.

Unit II:; Plant management practices in agroforestry; tree-crop interaction in agroforestry; concept of allelopathy and its impact on agroforestry, canopy management: lopping, prunning, pollarding and hedging;

Unit III: Palaeobotany: Fossilization and types of fossils; Geological time scale with dominant plant groups through ages; Fossil pteridophytes and gymnosperms of *Rhynia, Lyginopteris*, Importance of fossil study.

Unit IV: Palynology: Introduction to pollen morphology, Pollen wall structure and its significance, dispersal of pollen grains. Role of pollen morphology in plant taxonomy.

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, MR. Majumdar, SG 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. P. K. Ramachandran Nair , B. Mohan Kumar , Vimala D. Nair (2021), An Introduction to Agroforestry. Kulwer Academic publishers
7. Ranjith P. Udawatta, Shibu Jose (2021) Handbook of Agroforestry, Springer. Bhattacharya, K., Majumdar, M.R, Bhattacharya, S.G. (2006). A textbook of Palynology. New Central Book Agency (P) Ltd. Kolkata.

Embryology of Angiosperms

BOT/MJ/203
Credit: 4

Theory

Unit I: Pollination: definition, types of pollination; Fertilization: entry of pollen tube (chalazogamy, mesogamy, porogamy), double fertilization and triple fusion; significance of double fertilization; polyspermy; parthenocarpy, polyembryony, apomixis.

Unit II: Sexual incompatibility: Self- incompatibility, genetic basis of self-incompatibility, barrier to fertilization, physiology and biochemistry of incompatibility, ; biological significance of incompatibility, methods to overcome incompatibility.

Unit III: General account of microsporangium and microsporogenesis, megasporangium and megasporogenesis; Male and female gametophyte; structure of ovule, types of ovules.

Unit IV: Megagametogenesis (monosporic, bisporic, and tetrasporic); structure and development of embryo in monocotyledons and dicotyledons; types of embryo; types of endosperms (nuclear, helobial, cellular);

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

Practical

1. Study of dicot and monocot embryo (Permanent slides) 2.
Study of reproductive structure of a given plant sample
3. Study of different parts of a seed.
4. Study of effect of environmental stress on seed germination.

Bryophytes & Pteridophytes

BOT/MJ/204
Credit: 4

Theory

Unit I: General characteristics of bryophytes; Classification up to family (Smith's system of classification and ICBN system); Thallus structure, reproduction and life history of *Marchantia* and *Funaria* importance of bryophytes.

Unit II: *Evolution of Sporophytes; General characteristics of hornworts, liverworts and mosses.;* life histories of bryophytes with reference to *Riccia Polytrichum*

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. Fritsch F. E. (1945) The structure and reproduction of the algae Volume I & II, Cambridge
4. Graham J. E., Wilcox L. W., Graham L. E. (2008) Biology of the Red Algae. Benjamin Cummings
5. Sporne K. R. (2012)The Morphology of Pteridophytes, Scientific Publishers, New Delhi.
6. Sunderajan S. (2009) Introduction to Pteridophytes, New Age International Publishers, New Delhi. University Press, U. K.

Plant Anatomy and Gymnosperms

BOT/MJ/300
Credit: 4

Theory

Unit I: Internal organization of plant body: tissue system, types of cells and tissues; classification of tissues - simple and complex tissues; anatomy of stem, Organization of shoot apex; leaf: anatomy of dicot and monocot 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 of gymnosperms and general account of morphology-and reproduction of the following: *Cycas, Pinus, Gnetum*;

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

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

Practical

1. Anatomical study of
    a. stem,
    b. root,
    c. leaf (Primary structure)
2. Anatomical study of anomalous growth

Angiosperm morphology & Plant Systematics

BOT/MJ/301
Credit: 4

Theory

Unit I: Origin of Angiosperms, Classification of angiosperms with reference to the system of Bentham and Hooker, Introduction to chemotaxonomy, numerical and molecular taxonomy.

Unit II: Taxonomy Vs Systematics; Concept of species and hierarchical taxa, principles and rules of International Code of Botanical Nomenclature (ICBN); ranks and names; typification, author citation, valid publication, rejection of names.

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

Unit IV: Herbarium preparation and management; functions of Herbarium; Important herbaria and botanical gardens of the world and India; virtual herbarium; general account of the diagnostic feature and economic importance of the families :
Asteraceae, Solanaceae, Fabaceae, , Zingiberaceae, Orchidaceae.

Suggested Reading

1. Bhojwani,S.S. and Bhatnagar,S.D.(2004). The Embryology of Angiosperms. Vikas Publishing House, New Delhi.
2. Katherine Esau(1991). Plant Anatomy. Wiley Eastern University Ed.
3. Simpson, Micheal. G. 2011. Plant Systematics. Elsevier& Academic Press.
4. Singh, Gurucharan. 2012. Plant Systematics: Theory and Practice. Oxford & IBH, New Delhi.
5. Singh,V. and Jain,D.k.(2010). Taxonomy of Angiosperms. Rastogi Publications, Meerut.
6. Taik,V.N(1984). Taxonomy of Angiosperms. Tata Mc Graw Hill Pub.Co. Ltd. New Delhi.
7. Vasistha,B.R.(1998) Economic Botany. S. Chand & Co. Ltd. New Delhi.
8. Vasistha,P.C.(1996). Botany for Degree Students Vol V(Gymnosperms) S. Chand & Co. Ltd. New Delhi.

Practical

1. Study of morphology and reproduction structure of *Cycas/ Pinus/ Gnetum*.
2. Taxonomic studies of angiospermic plants belonging to families mentioned in Unit II.
3. Preparation of herbarium.

Plant Physiology

BOT/MJ/302
Credit: 4

Theory

Unit I: Water potential, water absorption, uptake and bulk movement of water, stomatal regulation of transpiration, anti transpirants; Inorganic nutrition, (macro and micro), deficiency symptoms (N,P,K,B,S), mineral absorption and translocation.

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

Unit III: Glycolysis, preparatory and pay-off phases, Kreb's cycle, electron transport chain, oxidative phosphorylation, Respiratory quotient, respiratory inhibitors. Growth and maintenance respiration

Unit IV: Physiological roles plant hormones- Auxins, Gibberlins, cytokinins, Abscisic acid and Ethylene, Synthetic growth regulators- Classification, their effect on plant growth and development. Stress and hormones with special reference to ABA.

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.

Microbiology and Plant Pathology

BOT/MJ/303

CREDIT: 4

Unit I: Introduction to Microbiology; History and scope of Microbiology; Classification of bacteria (morphological, nutritional); Structure of a bacterial cell; A brief account of genetic recombination (transformation, conjugation, transduction); Economic importance of Bacteria.

Unit II: Role of microorganism in Nitrogen cycle; Microbes in production of fermented food and alcoholic beverage; Antibiotics; Microbial enzymes in industry, production of enzymes. Microbes as Biofertilizers., microbial bioremediation

Unit III: Introduction to phytopathology: History and scope of Pathology. Transmission and spread of pathogens. General characteristics of Virus; classification of Virus (Baltimore), Structure of bacteriophages; Lysogenic and lytic cycles; TMV.

Unit IV Infection and host-pathogen interactions (pathogenesis and plant defense mechanism); Study of common plant disease (Blast of rice, Wheat rust and red rot of sugarcane, soft rot of ginger, citrus canker)

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. Observation and characterisation of fungal morphology (mycelium and spore bearing structure).
3. Observation and characterisation of algal morphology (vegetative and reproductive structures).
4. Study of disease specimens prescribed in theory papers by temporary preparations and with the help of permanent slides

Plant Biotechnology

BOT/MJ/304
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; Concept of selectable marker; Reporter genes; Basics of PCR, RNAi

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); Role of transgenics in bioremediation.

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.
7. Genes,

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).

Molecular Biology

BOT/MJ/305
Credit: 4

Theory

Unit I: Organization of DNA- Prokaryotes, Eukaryotes.; Types of DNA; Organization of Nucleosome; Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin

Unit II: DNA replication; General principles (bidirectional, semi- conservative and semi discontinuous replication); Enzymes involved in DNA replication; DNA damage and repair systems.

Unit III: Transcription in prokaryotes and eukaryotes; processing of mRNA; The Central Dogma; Salient features of Genetic code and wobble hypothesis

Unit IV: Translation: Ribosome structure and assembly; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis; Fidelity of translation; Inhibitors of protein synthesis.post translation modification.

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.
6. Sambrook J and Russel D.W (2001) Molecular Cloning-A laboratory manual. Vols IIII, Cold Spring Harbor Laboratory, USA.

Bioinformatics & Biostatistics

BOT/MJ/306
Credit: 4

Theory

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

Unit II: Introduction to BLAST, 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), 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

BOT/MJ/400
Credit: 4

Theory

Unit I: General account about the microbes used as biofertilizer – *Rhizobium* – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. *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.

Unit II: Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

Unit III: 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.

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 – field Application.

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

Floriculture

BOT/MJ/401
Credit: 4

Theory

Unit I: History of gardening; Importance and scope of floriculture and landscape gardening. Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit II: Flowering annuals; Herbaceous perennials; Divine vines; 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, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

Unit III: Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit IV: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, 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.

Phytochemistry

BOT/MJ/402
Credit: 4

Theory

Unit I: Collection of sample, identification and drying, Cold and hot solvent extraction (Soxhlet and otherwise) for analysis purpose

Unit II: Concentration of extract (Rotary evaporation/ air drying) and retrieving of solvent

Unit III: Solvent fractionation (using sperating funnel and solvent from polar to non polar like methanol/Chlorophorm/isopropanol/butanol/hexane/water.

Unit IV: Determination of each fraction for secondary metabolites. 1. Phenolic compounds Flavonoids/anthocyanin 2. Terpenes essential oils (Limonene/composite TLC) 3. Alkaloids (Aminoacids proteins (potato) or non protein seed of Cucurbitaceae 2D paper chromatography) 4. Screening each fraction for plant pathogens or human pathogens 5. Further analysis for active ingredient

Suggested Readings

1. Harborne. J.B. (1998). Phytochemical methods. A guide to modern techniques of Plant Anlysis. 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.

Aromatic Plants & their Products

BOT/MJ/403
Credit: 4

Theory

Unit I: Medicinal and Aromatic Plants, Cultivation and Cultural Practices, Disease Management and Scaping and Garden Design Application of manure, organic, chemical and Biofertilizers, micronutrients; Weed control; biopesticides.

Unit II Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

Unit III Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices;

Unit IV Identification of common diseases and pests of ornamentals, fruits and vegetable crops. Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

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

Plant Propagation & Tissue Culture

BOT/MJ/404
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: Techniques of preparation of soil, 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: Principles & techniques of tissue culture, Principles and practices of clonal selection. Preparation of stock solution and tissue media for micropropagation, Application of micropropagation

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,

Pomology

BOT/MJ/405
Credit: 4

Theory

Unit I: Definition, scope and importance of pomology, pomological systems, pomological collection, 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 (c) nut trees and small fruit crops species of subtropical and tropical origin.

Unit II Origin-spread, botanical classification, Economic importance-applications, Specific requirements for cultivation (soil management, fertilization, pruning, thinning, irrigation), Climate and soil, Propagation (rootstocks), Pruning, Pollination, Fertilization, Fruit growth, Harvest, Cultivars, Pests, Diseases, Physiological disorders

Unit III Registration procedure with new cultivars, vegetative and generative pomological traits, Botanical classification of cultivars and characteristics of the important traits. Planning and layout of orchards, preparation of land for orchard development, selection of planting materials and transplanting, protection of young plants, orchard management systems

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 Texkbook 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

BOT/MJ/406
Credit: 4

Theory

Unit I: Introduction to Intellectual Property Right (IPR Copyright Act and IPR, Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO). Objectives, Rights, Patent Act 1970 and its amendments.

Unit II: Procedure of obtaining patents, working of patents. Infringement of patents, Copyrights: work protected under copyright laws, Rights, Transfer of Copyright, and Infringement. Trademarks: Objectives of trademarks, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name.

Unit III: Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bioprospecting and Bio-piracy, Alternative ways, Protectability, need for a SuiGeneris regime, Traditional Knowledge on the International Arena, at WTO, at National level, Plant varieties protection in India. Rights of farmers, National gene bank; Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit IV: Computer Software and Intellectual Property, Database and Data Protection, Protection of Semiconductor chips, Domain Name Protection. Patenting Biotech Inventions: Objective, Applications, Concept of Novelty; Concept of inventive step, Microorganisms, and Moral Issues in Patenting Biotechnological inventions.

Suggested Readings

1. David Kitchin Q.C., Llewelyn, D., Mellor, J., Meade, R., Thomas Moody-Stuart, and D.
2. Gopalakrishnan, N.S. and Agitha, T.G. (2009). Principles of Intellectual Property Eastern Book Company, Lucknow.
3. Keeling, Jacob, R. (2005). Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxweel.
4. Narayanan, P. (2010). Law of Copyright and Industrial Designs; Eastern law House, Delhi.
5. Parulekar, A. and D' Souza, S. (2006). Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
6. 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

Nursery & Gardening

BOT/MJ/407
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 - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting. 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.

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 Musser & Andres, 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., SanFrancisco, USA