Master of Science

Botany

Syllabus

Faculty of Science

MAULANA AZAD UNIVERSITY, JODHPUR

M.Sc. Botany

Schemes for Internal Assessments and End Semester Examinations Semester-wise

Semester	Subject Code	Paper	CIA-I	CIA-II	ESE	Total
I Sem.	MSBO 111	Biology and Diversity of Microbes	10	10	80	100
	MSBO 112	Diversity and Systematics of Seed Plants: Angiosperms	10	10	80	100
	MSBO 113	Cell Biology	10	10	80	100
	MSBO 114	Cytology and Genetics	10	10	80	100
	MSBO 115	Plant Physiology	10	10	80	100
	MSBO 121	**Botany Lab-I**	10	10	80	100
	MSBO 122	**Botany Lab-II**	10	10	80	100
II Sem.	MSBO 211	Biology and Diversity of Lower Plants	10	10	80	100
	MSBO 212	Diversity and Systematics of Seed Plants - Gymnosperm	10	10	80	100
	MSBO 213	Molecular Biology	10	10	80	100
	MSBO 214	Genetics, Plant Breeding and Evolution	10	10	80	100
	MSBO 215	Plant Biochemistry and Metabolism	10	10	80	100
	MSBO 221	**Botany Lab-III**	10	10	80	100
	MSBO 222	**Botany Lab-IV**	10	10	80	100
III Sem.	MSBO 311	Fundamentals of Ecology	10	10	80	100
	MSBO 312	Plant Resource Utilization and Conservation	10	10	80	100
	MSBO 313	Plant Development	10	10	80	100
	MSBO 314	Plant Reproductive Biology	10	10	80	100
	MSBO 315	Fundamentals of Plant Tissue Culture	10	10	80	100
	MSBO 321	**Botany Lab-V**	10	10	80	100
	MSBO 322	**Botany Lab-VI**	10	10	80	100
IV Sem.	MSBO 411	Applied Ecology	10	10	80	100
	MSBO 412	Biostatistics and Bioinformatics	10	10	80	100
	MSBO 413	Genetic Engineering	10	10	80	100
	MSBO 414	Genomics and Proteomics	10	10	80	100
	MSBO 415	Applied Plant Tissue Culture				
	MSBO 421	**Botany Lab-VII**	10	10	80	100
	MSBO 422	**Botany Lab-VIII**	10	10	80	100

Semester-I		
MSBO 111: Biology and Diversity of Microbes		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Microbial diversity: Classical and modern methods and concepts. Domain and Kingdom concept in classification of microorganisms: criteria for classification, Recent trends in the classification of bacteria. Bacteria: structure, nutrition, Genetic recombination in Bacteria - transformation, transduction and conjugation; Cyanobacteria.	09
II	General account of Archaebacteria, Actinomycetes, L- forms, Mycoplasma, Spiroplasma and Phytoplasma. Plant Viruses: Morphology, Architecture, Chemistry, Isolation and Purification, Transmission and Genetics of Viruses. General account of Prions and Viroids.	09
III	Mycology: General characters and classification of fungi; substrate relationship in fungi; cell ultrastructure, unicellular and multicellular organization; cell wall composition; nutrition (necrotrophic, biotrophic and symbiotic); reproduction; heterothallism; heterokaryosis; parasexuality.	09
IV	Phylogeny of fungi: general account of Mastigomycotina (Synchytrium, Albugo, Peronospora), Zygomycotina (Rhizopus, Mucor, Pilobolus), Ascomycotina (Saccharomyces, Penicillium, Erysiphe, Phyllactinia, Morchella); Basidiomycotina (Polyporus, Puccinia, Uromyces, Melampsora), Deuteromycotina (Curvularia, Drechslera, Alternaria, Phoma, Fusarium, Colletotrichum); fungi in industry, medicine and as food; Mycorrhizae; fungi as biocontrol agents.	09
V	Principles of plant pathology, Concept of disease, Important symptoms and plant disease management. Molecular basis of host-parasite interaction. Causal organism, symptoms, disease cycle and control measures of: White blisters, downy mildew and green ear disease of bajra, downy mildew of crucifers, powdery mildew of wheat, black rust of wheat, smut of wheat, barley, sorghum and bajra, ergot of rye, groundnut leaf spot, red rot of sugarcane, Fusarium wilts, paddy blast, citrus canker, bacterial blight of paddy, angular leaf spot of cotton, Okra vein clearing, Potato viruses, Tomato leaf curl, Little leaf of brinjal, sesame phyllody, Sandal spike and Citrus greening.	09

RECOMMENDED READINGS

- Alexopoulos, CJ, Mims, CW & Blackwell, M 2007, Introductory Mycology, 4th edn, John Wiley and Sons Inc.
- Clifton, A 1958, Introduction to the Bacteria, McGraw-Hill Book Co., New York.
- Deacon, JW 2013, Modern Mycology, John Wiley and sons.
- Dubey, HC 2012, An lntroduction to Fungi, 4th edn, Scientific Publishers.
- Dubey, RC & Maheswari, DK 2014, A Textbook of Microbiology, S.Chand and Co., New Delhi.
- George, N Agrios 2005, Plant Pathology, 5th edn, Elsevier, Academic Press.
- Mandahar, CL 1990, Introduction to Plant Viruses, CRC Press.
- Mehrotra , RS & Aneja, KR , 2015 , An Introduction to Mycology, New Age International Publishers.
- Rangaswamy G & Mahadevan, A 1998, Diseases of Crop Plants in India, Prentice Hall of India Pvt. Ltd., New Delhi.
- Singh, RS 2009, Plant diseases, Oxford and IBH.
- Vashishta, BR & Sinha, AK 2014, Botany for Degree students: Fungi, S.Chand and Co., New Delhi.
- Webster, J & Weber, R 2007, Introduction to Fungi, Cambridge University Press.

Semester-I		
MSBO 112: Diversity and Systematics of Seed Plants: Angiosperms		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Fundamentals and importance of Plant Systematics and Taxonomy: Basic concepts and practices of plant taxonomy- Identification, nomenclature, salient features of International Code of Nomenclature. Taxonomic hierarchy; The concept of species, genus, family and other categories. Principles used in assessing relationship, delimitation of taxa and attribution of rank.	09
II	Classification systems: Phenetic versus Phylogenetic systems; Taximetrics and Cladistic methods in taxonomy; Relative merits and demerits of systems of Bentham and Hooker, Cronquist, Takhtajan and Thorne. The Angiosperm Phylogeny Group system of classification of flowering plants.	09
III	Taxonomic tools and evidences: Taxonomic literature, herbarium techniques, Digital and e- herbaria, morphological, anatomical, palynological, cytological, phytochemical, serological, biochemical and molecular techniques - genome analysis, nucleic acid hybridization and DNA bar-coding.	09
IV	Phylogeny of angiosperms: Ancestors of Angiosperms, Time of origin and Habit of Angiosperms, Primitive living Angiosperms, Inter-relationship among the major groups of angiosperms.	09
V	Origin of intra-population variations: Phenotypic plasticity, Plant Invasions and Introductions, Ecads and ecotypes. Speciation- various models. Hybridization and taxonomy- methods of analysis, hybrid complexes, taxonomic treatment of hybrids.	09

RECOMMENDED READINGS

- Angiosperm Phylogeny Group 2016, An Update of the Angiosperm Phylogeny Group Classification for the Orders and Families of Flowering Plants: APG IV, Botanical Journal of the Linnaean Society 181:1-20.
- Besse, P, 2014, Molecular Plant Taxonomy: Methods and Protocols, Humana Press.
- Cole, AJ, 1996 , Numerical Taxonomy, AcademicPress,London.
- Crawford, DJ, 2003, Plant Molecular Systematics, Cambridge University Press, Cambridge, UK.
- Davis, PH 2011, Principles of Angiosperm Taxonomy, Scientific Publishers.
- Davis,PH & Heywood,VH 1991,Principles of Angiosperm Taxonomy,Today and Tomorrow Publications, New Delhi.
- Grant,V 1971,Plant Speciation.ColumbiaUniversityPress, New York.
- Gurcharan Singh, 2010, Plant Systematics: An Integrative Approach, Science Publishers, Enfield, NH, USA.
- Harrison,HJ 1971, New Concepts in Flowering Plant Taxonomy, Heiman Educational Books Ltd., London.
- Heslop-Harrison J 1967, Plant Taxonomy, English Language Book Soc. & Edward Arnold Pub. Ltd., UK.
- Heywood, VH & Moore, DM 1984,Current Concepts in Plant Taxonomy, Academic Press, London.
- Jones, AD & Wilbins, A D 1971,Variations and Adaptations in Plant Species, Heiman & CoEducational Books Ltd., London.
- Judd, WS, Campbell, CS, Kellogg, EA, Stevens, PF & Donoghue, MJ, 2002, Plant Systematics: A Phylogenetic Approach, Sinauer Associates, Inc., Massachusetts.
- Mondal, A K 2011, Advanced Plant Taxonomy, New Central Book Agency (P) Limited.
- Nei, M & Kumar, S, 2000, Molecular Evolution and Phylogenetics, Oxford University Press, New York.
- Radford,AE 1986,Fundamentals of Plant Systematics, Harper & Row Publications,USA.
- Semple, C & Steel, MA, 2003, Phylogenetics, Oxford University Press, New York.
- Sharma, O P 2009, Plant Taxonomy, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
- Simpson, MG, 2006, Plant Systematics, Elsevier, Amsterdam.
- Singh, G (ed.) 2010, Plant Systematic: An integrated Approach, 3 rd edn, Science Publishers.
- Solbrig, OT & S o l b r i g , DJ 1 9 7 9 , Population Biology and Evolution, Addison-Wesley Publication Co. Inc., USA.

- Stace,CA 1989,Plant Taxonomy and Biosystematics, Edward Arnold Ltd., London.
- Stebbins, GL 1974 , Flowering Plant-Evolution above Species Level, Edward Arnold Ltd., London.
- Stuessy, TF, 2009, Plant Taxonomy: The Systematic Evaluation of Comparative Data, Columbia University Press, New York.
- Takhtajan, AL 1997, Diversity and Classification of Flowering Plants, Columbia University Press, NewYork.
- Verma, B K 2011, Introduction to Taxonomy of Angiosperms, PHI Learning Pvt. Ltd.
- Woodland,DW 1991, Contemporary Plant Systematics, Prentice Hall, NewJersey.

Semester-I		
MSBO 113: Cell Biology		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	The dynamic cell: Structural organization of the plant cell; specialized plant cell types; Chemical foundation: Atoms and Molecules, Covalent and Non-covalent interactions (Van der Waals, electrostatic, hydrogen bonding & hydrophobic interactions) Composition, structure and function of biomolecules: Carbohydrates, lipids, proteins, nucleic acids and Vitamins.	09
II	Cell wall: Structure and functions; biogenesis; growth; Plasma membrane: Structure of model membrane and functions; Active and Passive transport, Sites for ATPases, ion carriers, channels and types of pumps; receptors and electrical properties of membranes; Plant vacuole: Tonoplast membrane; ATPases; transporters; as storage organelle; Plasmodesmata: Structure, role in movement of micromolecules and macromolecules; comparison with gap junctions.	09
III	Plastid and Mitochondria: Structure and function; division and biogenesis; Plastome and Chondriome. Hydrogenosome; Ribosome, Endoplasmic reticulum, Golgi Apparatus: Structure and function; Protein sorting and targeting.	09
IV	Cell shape and mobility: The cytoskeleton; organization and role of microtubule and microfilament, motor movements; implication in flagellar and other movements; Other cellular organelles: Structure and function of microbodies, lysosome, Peroxisome; Nucleus: Structure; nuclear pores; chromatin organization, nucleolus; DNA polymorphism: A, B and Z forms and non-canonical forms of DNA; RNA polymorphism- mRNA, rRNA, tRNA and other regulatory RNAs	09
V	Microscopic techniques: Visualization of cells and sub-cellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission Electron Microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy; Flow cytometry and FACS; Centrifugation: Velocity gradient and Buoyant Density centrifugation; Chromatography: Paper, Thin layer and Column Chromatography (Gel permeation, Ion exchange, Affinity and HPLC)	09

RECOMMENDED READINGS

- Alberts, B,Johnson, A, Lewis, J, Raff, M., Roberts, K & Walter,P 2007, Molecular Biology of the Cell, 5th edn, Garland Publishing lnc, New York.
- Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
- De, DN 2000, Plant Cell Vacuoles: An Introduction, CSIRO Publication, Collingwood, Australia.
- Geoffrey, M, Cooper & Robert EH 2007, The Cell: A Molecular Approach, 4th edn, ASM Press
- and Sinauer Associates Inc, USA.
- Gunning, BES & Steer, MW 1995, Plant Cell Biology: Structure and Function, Jones and Bartlett Publishers, Boston, Massachusetts.
- Harris, N & Oparka, KJ 1994, Plant Cell Biology: A Practical Approach, IRL Press, Oxford University Press, Oxford, UK.
- Karp G & Vander GP 2005, Cell and Molecular Biology: Concepts and Experiments 4th edn, John Wiley & Sons Inc, USA.
- Kleinsmith, LJ & Kish, VM 1995, Principles of Cell and Molecular Biology, Harper Collins College Publishers, New York, USA.
- Jocelyn, EK, Stephen TK, Elliott, SG & Lewin, B 2014, Genes XI, Jones & Bartlett Learning, Burlington, Massachusetts.
- Lodish, H, Berk, A, Kaiser,CA, Kreiger,M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016 Molecular Cell Biology 8th edn, W.H. Freeman and Company, New York.
- Agarwal VK & Verma, PS, 2015, Cell Biology (Cytology, Biomolecules and Molecular Biology), S. Chand & Company Ltd.

Semester-I		
MSBO 114: Cytology and Genetics		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Cell Division: Mitosis and Meiosis, their regulation, cell cycle and its regulation. Stability and variability of DNA: The amount of DNA in nuclei and the C-value paradox. Unique and Repetitive DNA. The chromosomes in interphase: Euchromatin and Heterochromatin. Chromosome organization: Nucleosome, Solenoid and higher order structure.	09
II	Molecular organization of telomere and centromere, Chromosome banding Patterns: G banding, C banding, R banding and Q banding, Molecular basis of chromosome pairing, Specialized types of chromosomes: Polytene, Lampbrush and β-form chromosomes, Transposable elements in Bacteria and Plants.	09
III	Mutation: Types, causes and detection; mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural alteration in chromosome: Deletion, Duplication, Inversion, Translocation and Robertsonian translocation. Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination	09
IV	Numerical alteration in chromosomes: Aneuploidy and Euploidy. Polyploidy: Auto and Allopolyploid, their origin and genetic implications. Mendelian principles: Dominance, segregation, independent assortment, Deviation from Mendelian inheritance. Concept of gene: Allele, multiple alleles, pseudoalleles, complementation tests. Linkage and crossing over, Linkage maps, tetrad analysis	09
V	Extensions of Mendelian principles: Codominance, incomplete dominance, Gene interactions: Domianant and recessive epistasis, Complementary, Supplementary and duplicate genes. Pleiotropy, Penetrance and expressivity, phenocopy, Sex linkage	09

RECOMMENDED READINGS

- Alberts, B,Johnson, A, Lewis, J, Raff, M., Roberts, K & Walter,P 2007, Molecular Biology of the Cell, 5thedn, Garland Publishing lnc, New York.
- Brooker, RJ 2009, Genetics: Analysis and Principles 3rdedn, The McGraw-Hill Companies Inc., New York, USA.
- Burnham, CR 1984, Discussions in Cytogenetics, 7thedn, University of Minnesota, St. Paul.
- Geoffrey, M, Cooper & Robert EH 2007, The Cell: A Molecular Approach, 4thedn, ASM Press and Sinauer Associates Inc, USA.
- Gunning, BES & Steer, MW 1995, Plant Cell Biology: Structure and Function, Jones and Bartlett Publishers, Boston, Massachusetts, USA.
- Harris, N & Oparka, KJ 1994, Plant Cell Biology: A Practical Approach, IRL Press, Oxford University Press, Oxford, UK.
- Hardin, J, Bertoni, G &Kleinsmith, LJ 2012, Becker's-World of Cell, Pearson Benjamin Cummings, San Francisco, CA, USA
- Hartl, DL & Jones, EW 1998, Genetics: Principles and Analysis, 4thedn, Jones and Bartlett Publishers, Boston, Massachusetts, USA.
- Karp G & Vander GP 2005, Cell and Molecular Biology: Concepts and Experiments, 4thedn, John Wiley & Sons Inc, USA.
- Khush, GS 1974, Cytogenetics of Aneuploides. Academic Press, New York, USA.
- Kleinsmith, LJ & Kish, VM 1995, Principles of Cell and Molecular Biology, Harper Collins College Publishers, New York, USA.
- Lodish, H, Berk, A, Kaiser,CA, Kreiger,M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016Molecular Cell Biology 8th edn, W.H. Freeman and Company, New York.
- Pierce, BA 2005, Genetics: A Conceptual Approach, 2ndedn, WH freeman & Company, New York, USA.
- Snustad, DP & Simmons, MJ 2012, Principles of Genetics, 6thedn, John Wiley & Sons Inc, Hoboken, NJ, USA.
- Sumner, AT 2003, Chromosome: Organization and Function. Blackwell publishing, Oxford, UK.
- Tamarin, RH 2001, Principles of Genetics, 7thedn, The McGraw-Hill Companies Inc., New York, USA.

Semester-I		
MSBO 115: Plant Physiology		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Transport of Water - Components of water potential, water absorption by roots, pathways of movement of water in the root, mechanism of water transport through the xylem, transpiration and stomatal regulation; Mineral Nutrition - Essential nutrient elements, their functions and deficiency symptoms in plants; Solute Transport - Passive and active transport, root-microbe interactions in facilitating nutrient uptake; Transport of Organic Solutes - Pathway, materials translocated, the pressure-flow model, phloem loading and unloading.	09
II	Phytochrome - Discovery, photochemical and biochemical properties, characteristics of VLF, LF and HI responses, phytochrome-mediated responses including shade- avoidance response, mode of action; Cryptochrome- Discovery, chemistry, cryptochrome-mediated responses, mode of action; a brief account of phototropins; Photoperiodism - Discovery, critical day length, site of signal perception, circadian clock and photoperiodic time measurement, photoreceptors in flowering; photoperiodism in nature; Vernalization- Discovery, site of signal perception, vernalized (induced) and devernalized state.	09
III	Plant growth regulators: Discovery, chemical structure, occurrence, biosynthesis, physiological effects, commercial applications and signal transduction pathways of Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid and Brassinosteroids. A brief account of Strigolactones.	09
IV	Stress : Definition, types & plant responses (susceptibility, avoidance & tolerance); constitutive & induced responses; Biotic Stress : Production of physical barriers (cutin, suberin & wax) and secondary metabolites (terpenes, phenolics & N-containing compounds); induced plant defense against insect herbivores; plant defense against pathogens- elicitors, receptors & signaling, hypersensitive response & systemic acquired resistance; role of Salicylic acid & Jasmonic acid.	09
V	Abiotic Stress : Water deficit stress & drought tolerance, signaling ; Salt stress & adaptive strategies by plants, biochemical determinants & signaling ; Heat stress & adaptive strategies by plants , SOS signaling; Cold(chilling and freezing) stress & adaptive strategies by plants, role of ABA and antifreeze proteins; Oxidative stress & its causes, enzymatic and non-enzymatic antioxidants ; Heavy metal stress & adaptive strategies by plants, role of transporters and chelators. Chaperones and Chaperonins.	09

RECOMMENDED READINGS

- Ahmad, P & Wani, MR (eds.) 2014, Physiological Mechanisms and Adaptive Strategies in Plants Under Changing Environment, Springer, New York.
- Ahmad, P, Azooz, MM & Prasad, MNV (eds.) 2013, Salt stress in Plants: Signalling, Omics and Adaptations, Springer, New York.
- Aroca, R(ed.) 2012, Plant Responses to Drought Stress: From Morphological to Molecular Features, Springer Verlag Berlin Heidelberg.
- Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
- Davies, PJ (ed.) 2004, Plant Hormones : Biosynthesis, Signal Transduction, 3nd edn. Kluwer Academic Publishers, Dordrecht.
- Epstein, E & Bloom, AJ 2005, Mineral Nutrition of Plants : Principles and Perspectives, 2nd edn, Sinauer Associates Inc.USA.
- Gupta, D & Sandalio, LM (eds.) 2011,Metal Toxicity in Plants: Perception, Signalling and Remediation, Springer.
- Hedden, P & Thomas, SG 2006, Plant Hormone Signaling, Blackwell Publishing Ltd. Oxford, UK.
- Hopkins, WG & Huner,NPA 2008, Introduction to Plant Physiology,4th edn, John Wiley and Sons, Inc., New York, USA.
- Jenks, MA & Hasegawa, P (eds.) 2005, Plant Abiotic Stress, Blackwell Publishing Ltd. Oxford, UK.

- Nobel, PS 2009, Physicochemical and Environmental Plant Physiology, 4th edn. Academic Press, San Diego, USA.
- Noggle,GR & Fritz, GJ 1983, Introductory Plant Physiology, Prentice- Hall, Inc.
- Pandey, GK 2015, Elucidation of Abiotic Stress Signalling in Plants: Genomics and Proteomics Perspective,Vol, 1, Springer.
- Ricardo, A(ed.) 2012, Plant Responses to Drought Stress- From Morphological to Molecular Features, Springer.
- Salisbury, FB & Ross, CW 1992, Plant Physiology, 4th edn, Wadsworth Publishing Co., California, USA.
- Singhal, GS, Renger, G, Govindjee, Irrgang, K.D & Sopory, SK 1999, Concepts in Photobiology: Photosynthesis and Photomorphogenesis,Kluwer Academic Publishers.
- Taiz, L., Zeiger, E, Moller, IM & Murphy, A 2015, Plant Physiology and Development,6th edn, Sinauer Associates, Inc.USA.

Semester-I

MSBO 121: Practical - Botany Lab-I | **45 Hrs**

Part-A (Microbiology Suggested Laboratory Exercises)

- **Material A**: Gram Staining of Bacteria
- **Material B** : Study of Cyanobacteria (Nostoc, Oscillatoria, Microcystis, Lyngbya, Scytonema)
- **Material C (Fungi)**: Morphological study of representative members: Peronospora, Albugo, Mucor, Rhizopus, Saccharomyces, Chaetomium, Erysiphe, Phyllactinia, Melampsora, Polyporus, Penicillium, Aspergillus, Curvularia, Drechslera, Phoma, Colletotrichum, Alternaria and Fusarium.
- **Spots**
  - Study of morphology of bacteria, viruses, phytoplasma and cyanobacteria (photographs /slides) : TMV, Bacteriophage, Lactobacillus, Scytonema, Oscillatoria, Nostoc, Anabaena, Microcystis, Spiroplasma, L- forms and Phytoplasma (in Sieve Cells).
  - Study of Symptoms of the following diseases (Specimens / Photographs) :
    - ❖ Powdery mildew of Pea
    - ❖ Loose smut of Wheat
    - ❖ Smut of Bajra
    - ❖ Grain smut of Sorghum
    - ❖ Covered Smut of Barley
    - ❖ White rust of Crucifers
    - ❖ Head smut of Sorghum
    - ❖ Little leaf of Brinjal
    - ❖ Sesame phyllody
    - ❖ Paddy blast
    - ❖ Angular leaf spot of Cotton
    - ❖ Red rot of sugarcane
    - ❖ Ergot of Pearl Millet
    - ❖ Citrus canker
    - ❖ Potato Virus
    - ❖ Tomato leaf curl
    - ❖ Groundnut leaf spot
    - ❖ Downy mildew of Bajra
    - ❖ Bacterial blight of paddy
    - ❖ Wilts.
    - ❖ Sandal Spike

Part-B (Taxonomy Suggested Laboratory Exercises)

- **Description of a specimen from representative, locally available families (Material D). List of Locally Available Families:**
  - Ranunculaceae,
  - Capparidaceae,
  - Papaveraceae
  - Caryophyllaceae,
  - Fabaceaeae,
  - Cucurbitaceae,
  - Apiaceae,
  - Rubiaceae,
  - Asteraceae,
  - Primulaceae,
  - Plumbaginaceae,
  - Asclepiadaceae,
  - Convolvulaceae,
  - Zygophyllaceae
  - Portulacaceae,

- Phytollacaceae
- Bignoniaceae,
- Lamiaceae,
- Nyctaginaceae,
- Malvaceae,
- Tiliaceae,
- Sterculiaceae,
- Zygophyllaceae,
- Rhamnaceae.
- Molluginaceae,
- Euphorbiaceae,
- Cyperaceae
- Poaceae
- Polygonaceae,
- Chenopodiaceae, (31)Amaranthaceae,
- Aizoaceae,
- Solanaceae,
- Boraginaceae,
- Meliaceae
- Acanthaceae,
- Pedaliaceae

➢ Description of a species based on various specimens to study intra-specific variation: a collective exercise.
➢ Description of various species of a genus; location of key characters and preparation of keys at generic level.
➢ Location of key characters and use of keys at family level.
➢ Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
➢ Training in using floras and herbaria for identification of specimens described in the class.
➢ Educational Visit*****.

***** The students are expected to prepare a brief illustrated narrative of the Scientific Visits. After evaluation, the marks would be added to the CIA of the practical examination.

➢ **Spots**

- Vasculum
- Secateur
- Plant Press
- Drier
- Flora
- Types of inflorescence
- Types of leaf
- Types of placentat

RECOMMENDED READINGS

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Semester-I

MSBO 122: Practical - Botany Lab-II **45 Hrs**

- Determination of stomatal index (quantitative).
- Quantitative estimation of SOD activity.
- Demonstration of continuity of water column by the use of mercury in Cucurbita /Tinospora stem.
- Separation of Turmeric Alkaloids by TLC.
- Separation of amino acids by TLC.
- Smear preparations in Allium cepa or any other suitable material for mitotic studies.
- Meiotic studies in plants by slide preparation and/ or photographs.
- Karyotyping and preparation of photoidiogram.
- Study of Mendelian and non- Mendelian inheritance with the help of seed samples.
- Separation of biomolecules using gel permeation chromatography.
- Determination of mitotic index.
- Quantitative estimation of proline by Bates et al. method in the given plant sample.
- Studies on the effects of plant growth regulators.
- Quantitative estimation of antioxidants.
- Study of photoperiodism in Petunia.
- **Spots**
  - Cell membrane
  - Plasmodesmata
  - Secondary structure of protein
  - Flow cytometry
  - STEM
  - C-value paradox.
  - Robertsonian translocation
  - Transposable elements
  - Linkage maps
  - Chromosome organization
  - Active transport
  - Phloem loading and unloading
  - Photomorphogenesis
  - Effect of auxins on rooting
  - Elicitors

RECOMMENDED READINGS

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Semester-II		
MSBO 211: Biology and Diversity of Lower Plants		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Phycology: Algae in diversified habitats (terrestrial, fresh water & marine); thallus organization: cell ultrastructure; reproduction; criteria for classification of algae; Schemes of algal classification, Outline of Fritsch's & Smith's classification.	09
II	Salient features of Prochlorophyta, Chlorophyta (Coleochaete, Hydrodictyon, Ulva, Cladophora), Charophyta (Chara), Xanthophyta (Vaucheria), Bacillariophyta , Phaeophyta (Ectocarpus, Sargassum) and Rhodophyta (Batrachospermum, Polysiphonia); algal blooms, algal biofertilizers; algae as food, feed and uses in industry.	09
III	General characters and classification of bryophytes. General account of morphology, anatomy, reproduction of marchantiales (Marchantia, Plagiochasma, Astrella, Targionia), Jungermanniales (Pellia, Porella), Anthocerotales (Anthoceros), Sphagnales (Sphagnum), Funariales (Funaria) and Polytrichales (Polytrichum, Physcomitrella); economic and ecological importance.	09
IV	General characters and classification of pteridophytes. Stelar system in Pteridophytes. General account of morphology, anatomy and reproduction of pteridophytes with special reference to Psilopsida (Psilotum) and Lycopsida (Lycopodium, Selaginella & Isoetes), Heterospory and origin of seed habit.	09
V	General account of morphology, anatomy and reproduction of pteridophytes with special reference to Sphenopsida (Equisetum) and Pteropsida (Ophioglossum, Osmunda, Gleichenia, Pteris), Soral evolution, Alternation of generation, Apospory and apogamy; General account of fossil pteridophyta.	09

RECOMMENDED READINGS

- Kumar, HD 1999, Introductory Phycology, Affiliated East-West Press Ltd., New Delhi. 2 Morris, I 1986, An Introduction to the Algae, Cambridge University Press, U.K.
- Parihar, NS 1991, Bryophyta. Central Book Depot, Allahabad.
- Parihar, NS 1996, Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad. 5 Puri, P 1980, Bryophytes, Atma Ram and Sons, Delhi.
- Round, FE 1986, The Biology of Algae, Cambridge University Press, Cambridge.
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- Stewart, WN & Rothwell, GW 1993, Paleobotany and the Evolution of Plants, Cambridge University Press
- Vashishta, BR, Sinha, AK & Kumar,A 2014, Botany for degree students: Bryophyta, S.Chand and Co. Ltd., Delhi.
- Vashishta, BR, Sinha, AK & Singh, VP 2014, Botany for Degree Students: Algae, S.Chand and Co. Ltd., Delhi.
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Semester-II		
MSBO 212: Diversity and Systematics of Seed Plants - Gymnosperm		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Introduction: General characters, classification and economic importance of gymnosperms. Evolution of gymnosperms- Trends, origin of secondary wood, primary vasculature and leaf.	09
II	Brief account of families of Pteridospermales – Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae. General account of Bennettitales- Williamsoniaceae, Cycadeoidales- Cycadoeoidaceae, Cordaitales- Cordaitaceae.	09
III	Structure and reproduction: Cycadales- Cycadaceae; Ginkgoales- Ginkgoaceae; Coniferales- Taxodiaceae, Araucariaceae, Podocarpaceae, Cephalotaxaceae and Taxales- Taxaceae.	09
IV	Structure and reproduction: Ephedrales - Ephedraceae, Welwitschiales- Welwitschiaceae and Gnetales - Gnetaceae.	09
V	Paleobotany: Geological Time Scale; Process of fossilization, types and age of fossils, Paleopalynological techniques – Coal and Lignite maceration.	09

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- Bhatnagar, SP & Moitra, A 1997,Gymnosperms, New Age International (P)Ltd., Publishers, New Delhi.
- Biswas, C & Johri, BM 1997, Gymnosperms, Narosa Publishing House, New Delhi.
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- Sharma, OP 1997, Gymnosperms, Pragati Prakashan, Meerut, India.
- Singh, H 1978, Embryology of Gymnosperms, Encyclopedia of Plant Anatomy, X.Gebruder, Bortraeger, Berlin.
- Sporne, KR 1967, The Morphology of Gymnosperms, Hutchinson and Co. Ltd., London.
- Srivastava, HN 1998, Gymnosperms, Pradeep Publications, Jalandhar, India.
- Stewart, WN & Rothwell, GW 1993, Paleobotany and the Evolution of Plants,Cambridge University Press.
- Taylor, TN 1981, Palaeobotany: An Introduction to Fossil Plant Biology, Mc Graw-Hill Book Co. Inc. New York
- Vashishta, PC, Sinha, AK & Kumar, A 2009, Botany for Degree Students – Gymnosperms, S. Chand and company Ltd., New Delhi.

Semester-II		
MSBO 213: Molecular Biology		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Nature of genetic material, Central Dogma of life, Forward and Reverse genetics; DNA replication: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication; DNA damage and repair: Direct repair, Excision repair, Recombination repair and other repair mechanisms in plants; Organization of genes: Operons and interrupted genes, gene families, r-RNA, protein coding and t-RNA genes.	09
II	Transcription in plants: Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination; RNA processing: 5'capping, splicing, polyadenylation, RNA editing and Alternative processing mechanisms; Structure and function of different types of RNA and RNA transport; Transcription of plastid and mitochondrial genes and post-transcriptional processing.	09
III	Ribosome, Genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase; Translation in plants: Formation of initiation complex, initiation factors, elongation and elongation factors, termination; Translational proof- reading, translational inhibitors; Translation in plastids and mitochondria.	09
IV	Regulation of gene expression in plastids and mitochondria; Regulation of gene expression in plants at genomic level and genomic imprinting; Regulation of transcription and post transcriptional events in plants; Regulation of translation and post translational events in plants.	09
V	Mechanism of signal transduction in plants: Receptors, effectors , adaptors and secondary messengers; two component regulatory system in bacteria and plants, molecular mechanism of sucrose sensing.	09

RECOMMENDED READINGS

- Alberts, B,Johnson, A, Lewis, J, Raff, M., Roberts, K & Walter,P 2007, Molecular Biology of the Cell, 5th edn, Garland Publishing lnc, New York.
- Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
- Geoffrey, M, Cooper & Robert EH 2007, The Cell: A Molecular Approach, 4th edn, ASM Press and Sinauer Associates Inc, USA.
- Glick, BR & Thompson, JE 1993, Methods in Plant Molecular, Biology and Biotechnology, CRC Press, Boca Raton, Florida.
- Glover, DM & Hames, BD (eds) 1995, DNA Cloning 1: A Practical Approach, Core Techniques, 2nd edn, PAS, IRL Press at Oxford University Press, Oxford.
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- Kleinsmith, LJ & Kish, VM 1995, Principles of Cell and Molecular Biology, Harper Collins College Publishers, New York, USA.
- Krebs, JE, Goldstein, ES & Kilparick ST 2014, Lewin's Genes XI, Jones & Bartlett Learning, Burlington, Massachusetts.
- Lodish, H, Berk, A, Kaiser,CA, Kreiger,M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016
- Molecular Cell Biology 8th edn, W.H. Freeman and Company, New York.
- Malacinski, GM & Freifelder, D 1998, Essentials of Molecular Biology, Jones and Bartlet Publishers Inc., London.
- Shaw, CH (ed) 1988, Plant Molecular Biology: A Practical Approach, IRL Press, Oxford.
- Agarwal VK & Verma, PS, 2015, Cell Biology (Cytology, Biomolecules and Molecular Biology), S. Chand & Company Ltd.
- Wolfe, SL 1993, Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA .

Semester-II		
MSBO 214: Genetics, Plant Breeding and Evolution		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Transformation, transduction and conjugation; Mapping of genes in bacteria. Viral Genetics: Lambda phage-life cycle, regulation of gene expression, Mapping of genes in Viruses. Quantitative genetics: Polygenic inheritance, heritability and its measurements.	09
II	Molecular Techniques: Restriction Mapping-concept and technique, In-situ Hybridization-concept and technique,Site Directed Mutagenesis, Microarray, Southern, Northern and Western Hybridization, DNA foot printing, Yeast two hybrid system, Phage Display. Genetic variations in natural populations (Protein variation and variation with RFLP and DNA sequences)	09
III	Introduction to Plant Breeding: History and objectives of plant breeding; Centers of origin of cultivated plants, Genetic variability in crop plants and germplasm conservation, Plant Introduction and acclimatisation. Principles of breeding in self pollinated crops: Selection and Hybridization. Principles of breeding in cross pollinated crops: Genetic composition, Selection, Heterosis and inbreeding depression, Cytoplasmic Male sterility in plants.	09
IV	Methods of breeding in self pollinated crops- mass selection, pureline selection, pedigree selection, Bulk method and back cross method. Methods of breeding in cross pollinated crops- Population improvement, Hybrid and Synthetic varieties. Breeding work done on Wheat and Rice. Molecular plant breeding: Development of mapping population in plants, QTL mapping, Molecular marker systems, Importance of molecular marker assisted breeding	09
V	Evolution: Natural selection and Genetic Drift, concepts of neutral evolution. The Mechanisms of evolution: Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency, Speciation-allopatric, parapatric and sympatric; convergent evolution, Co- evolution.	09

RECOMMENDED READINGS

- Atherly, AG, Girton, JR & McDonald, JF 1999, The Science of Genetics, Saunders, College Publishing, Fort Worth, USA.
- Ayala, FJ & Avise, JC 2014, Essential Readings in Evolutionary Biology, Johns Hopkins University Press, Baltimore, Maryland.
- Brooker, RJ 2009, Genetics: Analysis and Principles, 3rd edn, The McGraw-Hill Companies Inc., New York, USA.
- Chahal, G S & Gosal, SS 2002, Principles and Procedures of Plant Breeding: Biotechnological and Conventional approaches. Alpha Science International Ltd., Oxford, UK.
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- Chopra, VL 2001, Plant Breeding: Field Crops, Oxford IBH, Pvt. Ltd.
- Chopra, VL 2001, Plant Breeding: Theory and Practice, Oxford IBH, Pvt. Ltd.
- Futuyma, DJ 2013, Evolution, 3rd edn, Sinauer Associates Inc, Sunderland, MA, USA
- Futuyma, DJ 1997, Evolutionary Biology, 3rd edn, Sinauer Associates Inc, Sunderland, MA, USA
- Gardner, EJ 2004,Principles of Genetics, 2nd edn, John Wiley and sons, New York, USA
- Gupta, PK 2010, Cytology, Genetics, Evolution and Plant Breeding, 2nd edn, Rastogi Publications, Meerut.
- Hartl, DL & Jones, EW 1998, Genetics: Principles and Analysis, 4th edn, Jones and Bartlett Publishers, Boston, Massachusetts, USA.
- Khush, GS 1973, Cytogenetics of Aneuploids, Academic Press, New York, London.
- Pierce, BA 2005, Genetics: A Conceptual Approach, 2nd edn, WH freeman & Company, New York, USA.
- Prasad, S 2006, Elements of Biostatistics, 2nd edn, Rastogi Publications, Meerut.
- Ridley, M 2003, Evolution, 3rd edn., Blackwell Publishing, Hoboken, NJ, USA
- Shukla, RS & Chandel, PS 2013, Cytogenetics, Evolution and Plant Breeding, S. Chand and Co. Ltd, New

Delhi.

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- Singh, BD 2012, Plant Breeding: Principles and Methods, Kalyani Publishers, Ludhiana.
- Snustad, DP & Simmons, MJ 2012, Principles of Genetics, 6th edn, John Wiley & Sons Inc, Hoboken, NJ, USA.
- Swaminathan, MS, Gupta, PK & Sinha, U 1983, Cytogenetics of Crop Plants. Macmillan India Ltd., Delhi.
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- Verma, PS & Agarwal VK 2004, Cell Biology, Genetics, Molecular Biology, Evolution & Ecology, S. Chand & Company Ltd.

Semester-II		
MSBO 215: Plant Biochemistry and Metabolism		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Bioenergetics: Laws of thermodynamics, Concept of entropy, enthalpy and Free energy. Enzymes: Characteristics, mechanism of action, reversible and irreversible inhibitions, Regulation of enzyme activity; Allosteric enzymes; Isoenzymes and their physiological significance; Steady – state enzyme kinetics for single substrate, Michaelis - Menten Equation ; Line weaver-Burk plot and determination of Km and Vmax; Effects of reversible inhibitors on apparent Km and Vmax.	09
II	Photosynthesis: General concepts and historical background; Photosynthetic pigments, Organization of Light – Absorbing antenna systems; Photo-oxidation of water, mechanism of electron and proton transport ; Photophosphorylation; Repair and Regulation of photosynthetic machinery; Carbon Assimilation- Calvin cycle and its regulation; Photorespiration and its significance.	09
III	Carbon dioxide- Concentrating Mechanisms: C4 cycle, Characteristics of C4 plants, C4 Variants -NAD-ME, NADP-ME and PEP-CK type ; C3-C4 intermediates, CAM pathway, Characteristics of CAM plants. Allocation of photo assimilates; Biosynthesis of starch and sucrose; Starch degradation: Hydrolytic and Phosphorolytic.	09
IV	Respiration: Glycolysis and bottom-up regulation, TCA cycle, Pentose phosphate pathway and glyoxylate cycle; Mitochondrial Electron transport and ATP synthesis; Alternative oxidase system and its significance. Lipid metabolism: Biosynthesis of saturated fatty acids–de novo biosynthesis and further modifications; Synthesis of membrane and storage lipids ; β-oxidation of saturated fatty acids, unsaturated fatty acids and fatty acids with odd– number of carbons.	09
V	Assimilation of nutrients: Mechanism of nitrate uptake, transport and assimilation; Ammonium assimilation; Symbiotic Nitrogen fixation: Plant-microbe interactions, nodule formation, nod factors; Nitrogenase enzyme complex and Energetics; Sulphur uptake, transport and assimilation.	09

RECOMMENDED READINGS

- Blankenship, RE 2002, Molecular Mechanisms of Photosynthesis, Blackwell Science, London.
- Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
- Dennis, DT, Turpin, DH, Lefebvre, DD & Layzell, DB 1997, Plant Metabolism, 2nd edn, Longman, Essex, England.
- Dey, PM & Harborne, JB (eds.) 1997, Plant Biochemistry, Elsevier.
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- Hopkins, WG & Huner,NPA 2009, Introduction to Plant Physiology,4th edn, John Wiley and Sons, Inc., New York, USA.
- Lea, PJ & Leegood, RC1998, Plant Biochemistry and Molecular Biology, 2nd edn, Wiley – Blackwell.
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- Taiz, L. and Zeiger, E 2006, Plant Physiology, 4th edn, Sinauer Associates, Inc., Publishers, Massachusetts, USA.

Semester-II

MSBO 221: Practical - Botany Lab-III **45 Hrs**

Morphological study of representative members of-

- **Material A-** Algae- Coleochaete, Hydrodictyon, Ulva, Cladophora, Chara, Stigeoclonium, Vaucheria, Pithophora, Closterium, Cosmarium, Polysiphonia, Batrachospermum, Ectocarpus, Sargassum
- **Material B-** Bryophyta- Marchantia, Plagiochasma, Targionia, Astrella, Pellia, Porella, Dumortiera, Anthoceros, Sphagnum, Funaria, Polytrichum
- **Material C-** Pteridophyta- Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Osmunda, Gleichenia, Pteris.
- **Material D-** Gymnosperms-
  Comparative study of the anatomy of (i) vegetative and (ii) reproductive parts of Cycas, Ginkgo, Pinus, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Podocarpus, Agathis, Taxus, Ephedra and Gnetum
- **Spots**
  Slides/ Specimens/ Photographs of **Material-A, B, C and D**
  Slide/ Specimens/ Photographs of the following fossil gymnosperms:
  - Williamsonia
  - Ptilophyllum
  - Bucklandia
  - Weltrichia

RECOMMENDED READINGS

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Semester-II

MSBO 222: Practical - Botany Lab-IV | **45 Hrs**

- Extraction of genomic DNA from given plant tissue using CTAB method.
- Visualization of isolated genomic DNA from plant sample by Agarose gel electrophoresis.
- Extraction of RNA from given plant tissue.
- Quantitative estimation of genomic DNA by DPA method..
- Quantitative estimation of RNA by orcinol method.
- Restriction digestion of DNA.
- Isolation of plasmid DNA from E. coli.
- Genetic problems on gene mapping in higher plants.
- Study of Centers of origin of crop plants.
- Demonstration of Emasculation and cross pollination in Datura.
- Extraction and Visualization of plant proteins using SDS-PAGE.
- Plotting Maximum Absorption spectrum of chlorophyll a and b.
- Quantitative estimation of chlorophyll a and b in C3 and C4 plants.
- Extraction and quantification of lipids by soxhlet method.
- Kinetic Studies- Effect of pH, Temperature, enzyme and substrate concentration on peroxidase activity.
- Demonstration of fluorescence in isolated plant pigments.
- Extraction and Visualization of Isoenzymes by Electrophoresis
- **Spots**
  - RNA polymerase
  - Lac operon
  - Plastome
  - Chondriome
  - Bacterial two component system 6 Restriction mapping
  - Microarray
  - Selection
  - Molecular marker
  - QTL mapping
  - Allosteric enzymes
  - Photosystems
  - ETC
  - Root nodules
  - CAM pathway

RECOMMENDED READINGS

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Semester-III		
MSBO 311: Fundamentals of Ecology		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Climate & Vegetation: Introduction to concept and development of ecology, experimentations & models. Atmosphere, Hydrosphere and Biosphere; microclimate.	09
II	Vegetation Organization, Soil biology and Fertility: Life zones; Major biomes; Adaptation, Tolerance and Homeostasis; Vegetation types of the world. Major soil types of the world; Biological Management of soil fertility; litter fall and decomposition, litter quality and climatic factors affecting C, N, P and S mineralization, nutrient synchronization.	09
III	Population Ecology: Concept of population, regulation. Competition and Life history patterns. r-selection and k-selection. Population genetics.	09
IV	Community Ecology: Concept of community; Analytical and Synthetic characters. Community coefficients. Inter-specific associations;Basic concepts of Ordination, Concept of habitat, Coexistence and Niche.	09
V	Ecosystem Structure and Functions: Primary productivity, measurements, global patterns and controlling factors. Succession: concept, types, mechanism and models, changes in ecosystem properties during succession. Energy attenuation in atmosphere and vegetation. Energy flow models and efficiency. Biogeochemical cycles C, N, P and S.	09

RECOMMENDED READINGS

- Barbour, MG, Burk, JH & Pitts, WD 1987, Terrestrial Plant Ecology Benjamin /Cummings Publication Company, California.
- Begon, M, Harper, JL & Townsend, CR 1996, Ecology, Blackwell Science, Cambridge, U.S.A.
- Brady,NC 1990,The Nature and Properties of Soils, MacMillan Co. Ltd., London.
- Cadish, G & Giller, KE 1997, Driven by Nature: Plant Litter Quality and Decomposition,CAB International Wallingford, U.K.
- Chapman, B & Bilharz, S 1997, Sustainability Indicators, John Wiley & Sons, NewYork.
- Chapman, JL, & Reiss MJ 2005, Ecology: Principles and Applications, Cambridge University Press.
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- Mason, CF 1991, Biology of Freshwater Pollution, Longman.
- Muller Dombois, D & Ellenberg, H 1974, Aims and Methods of Vegetation Ecology, Wiley, NewYork.
- Odum, EP 1971, Fundamentals of Ecology, Saunders, Philadelphia.
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- Treshow, M1985, Air Pollution and Plant Life,Wiley Interscience

Semester-III		
MSBO 312: Plant Resource Utilization and Conservation		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Domestication of plants & Origin of Agriculture: Plant Introduction,Wheat revolution in India, Impact of green revolution, green revolution phase- II, protective-productive agriculture.	09
II	Food security; Innovations for meeting World food demands. New dimensions of agricultural policy, Role of science, technology and women education in agriculture. Regimes of WTO, IPR issues and plant genetic resources of India.	09
III	Important fire-wood and timber yielding plants and non-wood forest products (NWFPs). Bamboos, Rattans, Raw materials for paper-making; Gums and resins, tannins and dye from natural plant resources. Origin, botany, cultivation and uses of Food, forage and fodder crops; Fibre crops; Medicinal and aromatic plants, and Vegetable and oil yielding crops; Plants used as avenue trees for shade, pollution control and aesthetics.	09
IV	Strategies for conservation: In situ conservation: International efforts and Indian initiatives, protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity.	09
V	Ex situ conservation: Principles and practices, botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks. General account and activities of Botanical Survey of India (BSI); Indian Council of Agricultural Research (ICAR), National Bureau of Plant Genetic Resources (NBPGR), Council of Scientific & Industrial Research (CSIR), Department of Science and Technology (DST), Department of Biotechnology (DBT), and Ministry of Environment, Forest and Climate Change (MoEFCC).	09

RECOMMENDED READINGS

- Arora, RK & Nayar, ER 1984, Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.
- Baker, HG 1978, Plants and Civilization. C.A. Wadsworth, Belmont.
- Chandel, KPS, Shukla, G & Sharma, N 1996, Biodiversity of Medicinal and Aromatic Plants in India: Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
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- Conway, G 1999, The Doubly Green Revolution: Food for All in the 21st Century, 1st edn, Comstock Publishing Associates.
- Council of Scientific & Industrial Research (1948-2005). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products, New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (2000).
- FAO/IBPGR 1989, Technical Guidelines for the Safe Movement of Germplasm. FAO/IBPGR, Rome.
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- Sofo,A (ed.) 2011, Biodiversity, Intech Publisher, DOI: 10.5772/1836.
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- Thakur, RS, Puri, HS & Husain, A 1989, Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.
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- Wickens, GE 2004, Economic Botany: Principles and Practices, Springer Science & Business Media.

Semester-III		
MSBO 313: Plant Development		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Introduction: Unique features of plant development, differences between animal and plant development. Seed germination and seedling development. Plant body architecture; primary and secondary thickening; Concept of stem cell in plants.	09
II	Shoot development: Organization of the shoot apical meristem (SAM); cytological and molecular analysis of SAM; control of cell division and cell to cell communication; control of tissue differentiation, especially xylem and phloem; secretory ducts and laticifers; wood development in relation to environmental factors; cellulose factories.	09
III	Nodal and floral anatomy of angiosperms; Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.	09
IV	Root development: Organization of root apical meristem (RAM); cell fates and lineages; vascular tissue differentiation; lateral roots; root hairs-development and function; root-microbe interactions.	09
V	Reproduction: Vegetative options and sexual reproduction; flower development; genetics of floral organ differentiation; homeotic mutants in Arabidopsis and Antirrhinum; mechanism of sex determination in plants.	09

RECOMMENDED READINGS

- Bewley, JD & Black, M 1994, Seeds: Physiology of Development and Germination, 2nd ed. Plenum Press, New York.
- Burgess, J 1985, An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.
- Fahn, A 1982, Plant Anatomy, 3rd edn, Pergamon Press, Oxford.
- Fosket, DE 1994, Plant Growth and Development:. A Molecular Approach. Academic Press, San Diego.
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- Raghavan, V 1999, Developmental Biology of Flowering Plants. Springer-Verlag, New York.
- Salisbury, FB & Ross, CW 1992, Plant Physiology. Wadsworth Publishing, Belmont, California.
- Waisel, Y, Eshel, A & Kafkaki,U (eds) 1997, Plant Roots: The Hidden Hall 2nd edn, Marcel Dekker, New York.

Semester-III		
MSBO 314: Plant Reproductive Biology		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Floral characteristics, Microsporangium & Male gametophyte: Structure of anthers; microsporogenesis, role of tapetum; pollen development and gene expression; sperm dimorphism and hybrid seed production; pollen germination, pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos.	09
II	Megasporangium & Female gametophyte: Ovule-structure, types and development; megasporogenesis; organization of the embryo sac, structure of the embryo sac cells. Functional role of accessory cells in embryo sac.	09
III	Pollination mechanisms and pollination vectors; breeding systems; commercial considerations; structure of the pistil; pollen- stigma interactions, sporophytic and gametophytic self- incompatibility (cytological, biochemical and molecular aspects);double fertilization and triple fusion; in vitro fertilization ,embryo culture, molecular mechanism of in vitro differentiation.	09
IV	Seed development and fruit growth: Endosperm development during early maturation and desiccation stages; embryogenesis, ultrastructure and nuclear cytology; cell lineages during late embryo development; storage proteins of endosperm and embryo.	09
V	Polyembryony; apomixis and apospory; dynamics of fruit growth; biochemistry and molecular biology of fruit maturation. Dormancy: Importance and types (seed and bud); Metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence, PCD/apoptosis in plants.	09

RECOMMENDED READINGS

- Bhojwani, SS & Bhatnagar SP 2009, The Embryology of Angiosperms, Vikas Publishing House, New Delhi.
- Burgess, J 1985, An Introduction to Plant Cell Development, Cambridge University Press, Cambridge.
- Fageri, K & Van der Pil, L 1979, The Principles of Pollination Ecology, Pergamon Press, Oxford.
- Proctor, M & Yeo, P 1973, ThePollination of Flowers, William Collins Sons, London.
- Raghavan, V 1997, Molecular Embryology of Flowering Plants, Cambridge University Press, Cambridge.
- Raghavan, V 1999, Developmental Biology of Flowering Plants, Springer-Verlag, New York.
- Raven, PH, Evert, RF & Eichhorn, SE 1992, Biology of Plants,Worth, New York.
- Sedgely, M & Griffin, AR 1989, Sexual Reproduction of Tree Crops, Academic Press, London.
- Shivanna, KR & Johri, BM 1985, The Angiosperm Pollen: Structure and Function, Wiley Eastern Ltd., New York.
- Shivanna, KR & Rangaswamy, NS 1992, Pollen Biology: A Laboratory Manual, Springer-Verlag, Berlin.
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- Steeves, TA & Sussex, IM 1989, Patterns in Plant Development,Cambridge University Press, Cambridge.
- The Plant Cell, Special Issue on Reproductive Biology of Plants, Vol. 5(10) 1993, The American Society of Plant Physiologists, Rockville, Maryland, USA

Semester-III		
MSBO 315: Fundamentals of Plant Tissue Culture		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	**Plant Tissue Culture**: General Introduction; Concept of Totipotency, Historical Background; Concept of asepsis and methods of sterilization, Laboratory planning and design, Basic tools and techniques of in vitro culture, Explant selection and surface sterilisation, Composition and preparation of tissue culture media.	09
II	**Micropropagation**: Pathways (Axillary bud proliferation, adventitious shoot bud differentiation, callus organogenesis and somatic embryogenesis), meristem tip culture , Applications and limitations.	09
III	**Somaclonal Variations:** Isolation of somaclonal variants-with and without in vitro selection, molecular basis of somaclonal variations, Applications and limitations. Haploid production through Androgenesis and Gynogenesis; In vitro fertilization and ovary culture, Production of Triploids through endosperm culture - advantages and limitations.	09
IV	**Protoplast Culture:** Isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization and methods of protoplast fusion; Selection of hybrids, Practical applications of somatic hybridization (hybrids/cybrids).	09
V	Slow growth and cryopreservation technique – importance of cryopreservation, pretreatment, freezing methods, cryoprotectants; Application of plant tissue culture in plant pathology; Production of virus - free plants-Thermotherapy, chemotherapy, virus indexing; Culture of obligate parasites.	09

RECOMMENDED READINGS

- Barbara, MR 2007, Plant Cryopreservation: A Practical Guide. Springer Verlag, Berlin, Heidelberg.
- Bhojwani, SS & Razdan, MK 1996, Plant Tissue Culture : Theory and Practice (revised edition), Elsevier Science ,Netherlands.
- Davey, Michael ,R & Anthony, P 2010, Plant Cell Culture: Essential Methods, Wiley-Blackwell Ltd.
- De, KK 1992, An Introduction to Plant Tissue Culture, New Central Book Agency, Kolkatta.
- Endress, R 1994, Plant Cell Biotechnology ,Springer –Verlag ,Berlin ,Heidelberg.
- Pauline, MD 1997, Hairy Roots: Culture and Applications, Harwood Academic Publishers.
- Purohit,SD 2013, Introduction to Plant Cell, Tissue and Organ Culture, PHI Learning Private Limited, Delhi.
- Razdan, MK 2003, An Introduction to Plant Tissue Culture, Oxford & IBH Publ. Ltd., New Delhi.
- Slater,A, Scott, N & Fowler, M 2003, Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press, UK.
- Thorpe, TA & Edward CY (eds) 2011, Plant Embryo Culture: Methods and Protocols, Springer Verlag, Berlin, Heidelberg.
- Vasil, IK & Thorpe, TA (eds) 2005, Plant Cell and Tissue Culture, Springer India Pvt. Limited, New Delhi.

Semester-III

MSBO 321: Practical - Botany Lab-V | **45 Hrs**

Ecology: Suggested Laboratory Exercises

- Determination of minimum size and number of quadrates required for reliable estimate of biomass in a natural field.
- Finding out association between important species using chi- square test.
- Comparison of protected and gochar land vegetation using similarity indices.
- Analysis plant communities using Bray-Curtis/Twin span ordination method.
- Determination of diversity indices (concentration of dominance, Shannon-Wiener, species richness, equitability and diversity) for protected and gochar land vegetation.
- Estimation IVI of the species in protected and gochar land vegetation
- Determination of productivity in terrestrial (Harvest method) and aquatic (Light and dark bottle method) systems.
- Determination of organic carbon content in protected and gochar land soils.
- Spots
  - Light and dark bottle method
  - Phenothermal index
  - Ecological Succession
  - Facilitation model of Succession
  - Y- shaped energy flow model
  - Biome
  - Microclimate
  - r- and k- selected species
  - Polar ordination method

Suggested Laboratory Exercises

- Quantification of starch in food crops (wheat, rice, maize, potato & sweet potato)
- Quantification of starch in forage/fodder crops (sorghum, bajra, gram & guar bean)
- Quantification of acid detergent fibre (ADF) content in fibre crops (cotton, jute, coir & silk Cotton)
- Morpho-anatomical features of plant fibres (cotton, jute, coir & silk cotton)
- Quantification of saponification value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
- Quantification of acid value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
- Quantification of iodine value in vegetable oils (mustard, groundnut, soybean, coconut,sunflower & castor)
- Micro-chemical test for fats & oils
- Micro-chemical test for gums (guar & kumbhatia)
- Micro-chemical test for tannins (Acacia, Terminalia, Cassia & tea leaves)
- Micro-chemical test for dyes (Butea & henna powder)
- Impurity test for natural products (honey, saffron, katha & mustard oil). Educational Visit*
  * The students are expected to prepare a brief illustrated narrative of the Scientific Visits. After evaluation, the marks would be added to the CIA of the practical examination.
- Spots
  - Food crops: wheat, maize potato, chickpea, sugarcane & sweet potato
  - Forage/Fodder crops: sorghum, bajra, gram & guar bean
  - Fiber crops: cotton, jute, coir & silk cotton
  - Medicinal plants: Papaver, Catharanthus, Adhatoda, Allium, Rauwolfia, Withania,
  - Phyllanthus & Aloe
  - Aromatic plants: Mentha, Rosa, Marjorana, Jasminum, Cymbopogon & Pandanus

RECOMMENDED READINGS

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Semester-III

MSBO 322: Practical - Botany Lab-VI — 45 Hrs

MSBO313: Plant Development

- Dissection of shoot apical meristem (SAM) to observe different zones in shoot apex of Hydrilla.
- Study of root morphology and root apical meristem (RAM) in Eichhornia.
- Study of anatomy of stem to observe the growth due to environmental conditions. (Bignonia & Salvadora stem).
- Study of anatomical structure of C3 & C4 leaves (T.S. of Nerium, Wheat & Zea mays leaves).
- Study of origin of lateral roots.

MSBO314: Plant Reproductive Biology

- Study of pollen germination under different conditions of solution. 2 Study of Trichomes (Hibiscus rosa-sinensis / Althea rosea).
- Testing the viability of given seed sample.
- Determination of pollen stainability & percentage pollen stainability to test pollen viability.
- Study of various types of placentation (T.S. of ovary of given flower). 6 Dissection and mounting of translator.
- Study of T.S. of mature anther.

MSBO315: Fundamentals of Plant Tissue Culture

- Preparation of the stock solutions for MS medium.
- Preparation of MS medium from stock solutions.
- Isolation, preparation, surface sterilization and inoculation of different explants.
- Effect of auxins and cytokinins on callus growth and organogenesis.
- Effect of auxins and cytokinins on shoot multiplication.
- Experiments on multiple shoot induction from mature nodal shoot segments of economically important plant species.
- Differentiation of tissues through organogenesis/ somatic embryogenesis.

- **Spots**

MSBO313: Plant Development

- T.S. Stem (Bignonia & Salvadora)
- T.S. Leaves (Nerium, Wheat & Zea mays)
- Kranz anatomy
- Types of Stomata
- Mycorrhiza
- Root Nodules

MSBO314: Plant Reproductive Biology

- T.S of mature anther
- Types of placentation (Axile, Parietal, Marginal, Free central, Basal)
- Ranslator Ruminate endosperm
- Types of ovules
- Fruit ripening
- Senescence
- Apomixis
- Sex determination in plants

MSBO315: Fundamentals of Plant Tissue Culture

- Multiple shoot
- Callus Culture

- Somatic embryogenesis
- Protoplast
- Synthetic seed
- Somatic hybridization
- Cryopreservation
- In-vitro Rooting

RECOMMENDED READINGS

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Semester-IV		
MSBO 411: Applied Ecology		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Ecology Stability & Management: Ecosystem services, Concept of ecosystem resistance and resilience. Natural and anthropogenic ecological perturbation and their impact on plants and ecosystem. Ecosystem restoration; Ecology of plant invasion.	09
II	Biodiversity and Ecological Management: Biodiversity concept and levels, biodiversity role in ecosystem function and stability. Speciation and extinction; IUCN categories of threat; distribution and global patterns. Convention on Biological Diversity (CBD)Terrestrial biodiversity hot spots.	09
III	Sustainable development: Concept of sustainable development; Capitals and currencies , problems and solutions. Concept of sustainable consumption, sustainability indicators; Food security and human population growth.	09
IV	Environmental pollution and industrial ecology: Air, water and land pollution kinds, sources, effects on plants and ecosystem. Bioremediation, environment impact assessment, concepts of industrial ecology.	09
V	Climatic changes and consequences: The greenhouse effect, greenhouse gases; CO_2, CH_4, N_2O, CFCs sources, trends and role; Global warming; Ozone layer and hole; Consequences of climatic changes:CO_2 fertilization, sea level rise and radiation; Concept of carbon credit.	09

RECOMMENDED READINGS

- Barbour, MG, Burk, JH & Pitts, WD 1987,Terrestrial Plant Ecology Benjamin /Cummings Publication Company, California.
- Begon, M, Harper, JL & Townsend, CR 1996, Ecology, Blackwell Science, Cambridge, U.S.A. 3 Brady,NC 1990,The Nature and Properties of Soils, MacMillan Co. Ltd., London.
- Cadish, G & Giller, KE 1997, Driven by Nature: Plant Litter Quality and Decomposition, CAB International Wallingford, U.K.
- Chapman, B & Bilharz, S 1997, Sustainability Indicators, John Wiley & Sons, NewYork.
- Chapman, JL, & Reiss MJ 2005, Ecology: Principles and Applications, Cambridge University Press.
- Heywood,VH & Watson, RT 1995, Global Biodiversity Assessment, Cambridge University Press. 8 Hill, MK 1997, Understanding Environmental Pollution Cambridge University Press.
- Koromondy, EJ 1996, Concepts of Ecology, Prentice-Hall of India Pvt. Ltd., New Delhi. 10 Ludwig, J & Reynolds, JF 1988, Statistical Ecology, John Wiley & Sons New York.
- Mason, CF 1991, Biology of Freshwater Pollution, Longman.
- Muller Dombois, D & Ellenberg, H 1974, Aims and Methods of Vegetation Ecology, Wiley, NewYork.
- Odum, EP 1971, Fundamentals of Ecology, Saunders, Philadelphia. 14 Odum,EP 1983, Basic Ecology, Saunders, Philadelphia.
- Rana, SVS 2005, Essentials of Ecology and Environmental Science, Prentice Hall of India.
- Smith, RL 1996, Ecology and Field Biology, Harper Collins, NewYork.
- Treshow, M 1985, Air Pollution and Plant Life,Wiley Interscience.

Semester-IV		
MSBO 412: Biostatistics and Bioinformatics		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Introduction to statistics, designing and methodology of an experiment, sample and sampling techniques, collection and representation of data (diagrammatic and graphical). Measures of Central tendency: Mean-Arithmetic, Geometric and Harmonic Mean; Median, Mode.	09
II	Measures of Dispersion: Range-characteristics, coefficient, merits and demerits, Variance and Standard Deviation-calculation, merits and demerits, standard error, coefficient of variation, Measures of Skewness and Kurtosis, Probability distributions (Normal, Binomial and Poisson),Confidence Limits.	09
III	Idea of two types of errors and level of significance, Paired Mean Comparison (t- test; Chi-square).Multiple Mean Comparison (DMRT), Analysis of variance- RBD and its application in resource evaluation. Correlation-Types, Methods, Deduction of auto correlation, Correlation Coefficient; Simple Regression analysis and its coefficient, Computer application in data analysis (MS-Excel and SPSS).	09
IV	Introduction to computer: component, generation and types. Introduction to Internet: history, IP address, URL, types of networking and applications. Introduction to bioinformatics: definition, history and principle. Database concept, biological databases (GENBANK, DDBJ, EMBL, SWISSPROT, PROSITE), types of nucleotide sequences, types of databases (primary, secondary, composite databases), information retrieval from databases.	09
V	Sequence analysis: homology search, sequence alignment: types and methods of alignment, alignment score, multiple sequence alignment and ClustalW. Phylogenetic analysis: Dendrogram, Cladogram, Extraction of a phylogenetic data set, Tree building methods (UPGMA, NJ, MP, ML), Tree evaluation (Boot strap and Jack knifing) and use of various software (TREE VIEW, PHYLIP) in phylogeny and genetic diversity analysis.	09

RECOMMENDED READINGS

- Baxevanis, AD & Ouellette,BFF 2004, Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins, 2nd edn, Wiley Publishers.
- Bergeron, B 2002, Bioinformatics Computing, Pearson Education, US.
- Daniel WW 1999, Biostatistics-A foundation for Health Science, John Wiley.
- Khan IF & Khanum A 2004, Fundamentals of Biostatistics, Ukaaz Publications, Hyderabad.
- Lesk, AM 2010, Introduction to Bioinformatics, Oxford University Press, USA.
- Medhi J, Statistical Methods, Willey Eastern Limited.
- Mount, DA 2004, Bioinformatics: Sequence and Genome Analysis, 2nd edn, CSH Press, UK.
- Orengo, CA & Thornton JM 2009, Bioinformatics: Genes, Proteins and Computers, Taylor and Francis, US.
- Prasad, S 2013, Elements of Biostatistics, 3rd edn, Rastogi Publications, Meerut.
- Rashidi, H & Buchler, LK. 2005, Bioinformatics Basics: Application in Biological Science and Medicine, CRC Press.
- Rastogi, Veer Bala 2009, Fundamentals of Biostatistics, 2nd edn, Ane Books Pvt. Ltd, New Delhi.
- Simpson, RJ (ed.) 2008, Proteins and Proteomics: A Lab Manual, Cold Spring Harbor, US.

Semester-IV		
MSBO 413: Genetic Engineering		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Tools and techniques: Restriction enzyme, DNA ligase, polynucleotide kinase, alkaline phosphatase, DNA polymerase, terminal transferase. RNAse and DNAse; Reverse transcriptase. Vector: Characteristics of plasmids (pBR322 and pUC19), phages, phagemids, cosmids, viruses, YAC and BAC as vector.	09
II	DNA cloning strategies - steps involved. Cohesive and blunt end ligation: Linkers, Adaptors, Homopolymeric tailing. Preparation and screening of genomic and cDNA libraries. Reporter and Marker genes. Screening of recombinants- insertion inactivation, blue-white screening, Immunological screening and Colony Hybridization.	09
III	Genetic engineering of plants: Aims, strategies for development of transgenics; Methods of gene transfer: Physical, Chemical and Biological methods Agrobacterium- the natural genetic engineer; Mechanism of tumour formation by A. tumefaciens; Vectors engineered from Ti Plasmid; Root formation using Agrobacterium rhizogenes.	09
IV	Gene expression and function: Expression vectors- pMal, GST, pET-based vectors. Study of- transcript of cloned gene, regulation of gene expression, translation product of cloned gene and protein-protein interactions.	09
V	Application of plant transformation for productivity and performance: herbicide resistance, insect resistance with special reference to Bt genes, virus resistance, Terminator gene technology and quality improvement; Transplastomics. Biosafety and Bioethics; Containment facilities, Biotechnology risk assessment, Patenting life forms.	09

RECOMMENDED READINGS

- Brown, TA 2010, Gene Cloning and DNA Analysis: An Introduction, 6th edn, Wiley-Blackwell publishing, UK.
- Chawla, HS 2009 Introduction to Plant Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Dale, JW, Schantz, M & Plant, N 2011, From Genes to Genomes: Concepts and Applications of DNA Technology, 3rd edn, Wiley-Blackwell publishing, UK
- Gibson ,G & Muse, SV 2004 , A Primer of Genome Science,2nd edn, Sinauer Associates, USA
- Glick, BR & Pasternak JJ 1998, Molecular Biotechnology, 2nd edn, ASM Press, Washington DC.
- Greene, JJ & Rao VS (eds) 1998, Recombinant DNA–Principles and Methodologies. Marcel Dekker, New York.
- Gupta, PK 2012, Biotechnology and Genomics, 1st edn, Rastogi publications, Meerut.
- Hansen, E & Harper, G (eds) 1997, Differentially Expressed Gene in Plants, Taylor and Francis Ltd. London.
- Joshi, P 2007,Genetic Engineering and Its Applications, 2nd edn, Agrobios- India, Jodhpur.
- Primrose, SB & Twyman RM 2015, Principles of Gene Manipulation and Genomics, Blackwell Science, Oxford, UK.
- Sambrook, J, Fritsch, EF & Maniatis, T 1989, Molecular Cloning-A Lab Manual, 2nd edn, Cold Spring Harbor Laboratory Press, New York.
- Sandhya Mitra 2000, Genetic Engineering- Principles and Practice. Macmillan India Limited, New Delhi.
- Satyanarayana, U 2005, Biotechnology, 1st edn, Books and Allied Publishers, Kolkata.
- Singh, BD 2012, Biotechnology: Expanding Horizons, 4th edn, Kalyani Publishers, Ludhiana.

Semester-IV		
MSBO 414: Genomics and Proteomics		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Introduction to Genomics- Structural, Functional, Comparative and Evolutionary genomics ; Plant genomes; Indian initiatives in plant genome sequencing.	09
II	DNA sequencing methods: Dideoxy chain termination, Pyrophosphate sequencing. High throughput , Ultra high throughput sequencing. Tools for genome analysis-PCR-Working and types; Molecular markers: RFLP,DNA Fingerprinting and its applications ,RAPD, AFLP, SSR, SNP.	09
III	Proteome: definitions and conceptualization; Protein structure; Post-translational modifications(PTM) -phosphorylation, glycosylation, ubiquitination, additional modifications; Mass spectrometric characterization of PTM –Identification of phosphorylated , glycosylated proteins and other PTM.	09
IV	Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Peptide fingerprinting; MALDI-TOF; Differential display proteomics, Protein-protein interactions.	09
V	Functional genomics and proteomics: Microarrays ; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics; Concept of Transcriptomics, Metabolomics and Metagenomics.	09

RECOMMENDED READINGS

- Campbell, AM & Heyer, LJ 2007,Discovering Genomics, Proteomics and Bioinformatics,2nd edn, Benjamin Cummings Publ. Co., San Francisco, California, USA.
- Gibson ,G & Muse, SV 2004 , A Primer of Genome Science,2nd edn, Sinauer Associates, USA.
- Glick, BR & Pasternak, JJ 1998 , Molecular Biotechnology, 3rd edn, ASM Press, USA.
- Primrose, S & Twyman R 2006, Principles of Gene Manipulation and Genomics, 7th edn, Blackwell Publ. Co., London.
- Sambrook, J, Fritsch, EF & Maniatis, T 1989,Molecular Cloning-A Lab Manual, Cold Spring Harbor Laboratory Press, New York.
- Veenstra ,TD & Yates, JR 2006, Proteomics for Biological Discovery, Wiley-Liss.

Semester-IV		
MSBO 415: Applied Plant Tissue Culture		**45 Hrs**
इकाई Unit	**पाठ्यक्रम सामग्री Course Content**	**Hours/ Unit**
I	Planning and design of tissue culture facility for mass propagation of plants: Concept of clean area. Mass media preparation, dispensation and storage. Autoclaving and contamination control. Hatcheries, transfer area, control of physical environment in growth room, air –handling and conditioning, culture room lighting, air exchange, humidity control.	09
II	Greenhouse location and design. General nursery practices, maintenance of plants under nursery shade. Available technologies for micropropagation of ornamentals, fruit plants, plantation crops, spices and condiments, oil seeds and legumes, commercialization of plant tissue culture in India.	09
III	Principal classes of secondary metabolites (alkaloid, terpenes, phenolics), shikimic acid and mevalonate pathways. Production of pharmaceutically important drugs in culture – alkaloids (Catharanthus, Nicotiana, Papaver), anti-tumour agents (taxol, podophyllotoxins, vincristine), saponins and sterols (diosgenin, guggul, ginseng); food additives (sweetners, flavours and colours) and insecticides. Basic methods of extraction and isolation of secondary metabolites: alkaloids, polyphenolics and terpenes.	09
IV	Bioreactors: types of bioreactors (stirred tank, air lift, membrane type, immobilized cell bioreactors), process and operation, factors affecting the mass scale production of secondary metabolites (optimization, selection, hairy roots, elicitation).	09
V	Bioconversion of molecules by cell free system, and cell cultures, freely suspended and immobilized cells and enzymes. Molecular farming: production of drugs by genetic engineering technology, metabolic engineering for the production of useful metabolites.	09

RECOMMENDED READINGS

- Barbara M Reed 2008, Plant Cryopreservation: A Practical Guide. Springer.
- Bhojwani, SS & Razdan, MK 1996, Plant Tissue Culture: Theory and Practice. Elsevier Science Publishers, New York. USA.
- Edwin F,George, Michael A. Hall, Geert-Jan De Klerk 2007, Plant Propagation by Tissue Culture(Vol I): The Background. Springer.
- Evans, DE, Coleman, JOD & Kearns, A 2003, Plant Cell Culture. BIOS Scientific Publishers.
- Fett-Neto, AG (ed) 2010, Plant Secondary Metabolism Engineering Methods and Applications , Humana Press.
- Gamborg, OL &Phillips, GC 2005, Plant Cell, Tissue and Organ Culture, Fundamental Methods. Narosa Publishing House, New Delhi.
- Ignacimuthu,S 2015, Biotechnology: An Introduction. Narosa Publishing House.
- Kirakosyan, A & Kaufman, PB 2009, Recent Advances in Plant Biotechnology, Springer.
- Michael R Davey& Paul Anthony 2010, Plant Cell Culture: Essential Methods. Wiley-Blackwell A John Wiley & Sons, Ltd.
- Purohit, SD 2013, Introduction to Plant cell, Tissue and organ culture. PHI Learning Private Limited, Delhi.
- Ramawat, KG & Merillon, JM (eds.) 2013, Natural Products: Phytochemistry, Botany and Metabolism of Alkaloids, Phenolics and Terpenes, Oxford& IBH, Pvt. Ltd.
- Ramawat, KG & Merillon, JM 2010, Biotechnology: Secondary metabolites, Oxford & IBH, Pvt. Ltd.
- Ramawat, KG 2000, Plant Biotechnology. S. Chand & Co., New Delhi.
- Ramawat, KG 2006, Biotechnology: Secondary metabolites : Plant and Microbes, Science Publisher
- Singh, RS & Singh, MP 2007, Fundamentals of Plant Biotechnology, Satish Serial Publishing House, Delhi.
- Slater,A, Scott, N & Fowler, M 2003, Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press.
- Trevor A Thorpe & Edward C. Yeung (eds.) 2008, Plant Embryo Culture: Methods and Protocols. Springer.

- Wink, M 2010 (ed), Annual Plant Review,Volume 39, Functions and Biotechnology of Plant Secondary Metabolites, 2nd edn, Willey Blackwell.
- Woung-Young Sou & Bhojwani, SS (eds.) 1999, Morphogenesis in Tissue Cultures. Kluwer Academic Publishers.

Semester-IV

MSBO 421: Practical - Botany Lab-VII **45 Hrs**

- Water quality assessment for polluted water bodies:
  - Physical- Color, odor, pH, Electrical conductivity, transparency
  - Chemical- CO3--, HCO3-, Cl-, Hardness, Dissolved oxygen.
  - Biological- Pathogenic and non-pathogenic microorganisms.
- Growth curve / biomass quantification in terms of protein for bio-remediating protists.
- Comparison of community status in disturbed and undisturbed areas.
- Comparison of soil microbial biomass/ carbon in unpolluted and polluted soil.
- Estimation of chlorophyll content in SO2 fumigated and unfumigated plant.
- Estimation of rate of soil respiration by alkali absorption method.
- Study of environmental impact of a given developmental activity using checklist as a EIA method.
- Calculation of mean, variance, standard deviation, standard error, coefficient of variation and to use t-test for comparing two means related to ecological data.
- Finding out the relationship between two ecological variables using correlation and regression analysis.
- Finding the association between important species using chi- square test.
- **Spots**
  - Seed output and reproductive capacity of plants
  - Digital color checker
  - Odour meter
  - pH meter
  - Turbidometer
  - Sulphate estimation
  - Alkali absorption method
  - Litter bag method
  - EIA checklist method

BIOSTATISTICS AND BIOINFORMATICS: SUGGESTED LABORATORY EXERCISES

- Retrieval of required sequence from search engine.
- Homology search for given unknown sequence using BLAST.
- Similarity search using FASTA.
- Primer designing for given nucleotide sequences.
- Multiple sequence alignment using suitable software.
- Searching Exon coding regions, Intron and SNPs in the given nucleotide sequence.
- Preparation of phylogenetic tree
- Measurement of Central Tendency-Mean, Mode and Median.
- Measurement of Variance and Standard Deviation
- Chi Square Test
- Analysis of variance (RBD)
- Analysis of Correlation and Regression
- Phylogenetic study of biological samples through PHYLIP
- **Spots**
  - BLAST
  - NCBI
  - EMBL
  - FASTA
  - MSA (Multiple sequence alignment)
  - Phylogeny tree (cladogram, dendrogram) 7 PHYLIP
  - Clustal W
  - ANOVA
  - t-test

- Standard deviation
- Standard error

RECOMMENDED READINGS

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Semester-IV

MSBO 422: Practical - Botany Lab-VIII | **45 Hrs**

- Isolation of plasmid DNA from bacteria. (minipreparation of plasmid)
- Performing restriction and digestion of lambda phage DNA. (kit based)
- Performing DNA ligation of restricted lambda DNA. (kit based)
- Preparation of competent cells of bacteria. (kit based)
- Transformation of E. coli cells with standard plasmids. (kit based)
- Calculation of transformation efficiency.
- Demonstration of polymerase chain reaction.
- Construction of restriction map of the plasmid pBR322.
- Experiments on multiple shoot induction from mature nodal shoot segments of economically important plant species.
- Demonstration of anther culture in Datura.
- Encapsulation of somatic embryos/buds using alginate.
- Preparation of in vitro rooting medium.
- Experiments on in vitro root induction from cultured shoots.
- Experiment on ex vitro rooting.
- Establishment of suspension culture.
- Extraction & separation of secondary metabolites using TLC.
- **Spots**
  - Southern Hybridization
  - Western Hybridization
  - Biochip
  - Biosensors
  - Bacterial Artificial Chromosome (BAC)
  - Yeast Artificial Chromosome (YAC)
  - Ti Plasmid
  - SDS-PAGE
  - Protein- protein interactions
  - Restriction enzymes
  - Green House
  - Growth Room
  - Bioreactor
  - Thermocycler
  - Transplastomics
  - Molecular Farming
  - Reporter and marker genes
  - MALDI
  - Expression Vector
  - Taxol

RECOMMENDED READINGS