MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –IV

M4BOT01-CT11	PLANT TISSUE CULTURE AND GENETIC ENGINEERING

Unit-I Credit hours: 12

Concept of cell totipotency, cellular differentiation and morphogenesis. Explant selection, In vitro regeneration of plants: Different pathways of micropropagation (Enhanced axillary branching, *de novo* shoot bud differentiation, somatic embryogenesis and callus organogenesis) and their applications. Shoot tip culture.

Unit-II Credit hours: 12

Protoplast technology: Protoplast isolation, culture, regeneration and maintenance, Viability tests for protoplast generation, Regeneration from protoplasts, Methodology adopted in protoplast fusion and their application in plant research. Somatic hybridization. Somaclonal variation-its causes and consequences.

Unit-III Credit hours: 12

Recombinant DNA Technology: – Vectors types and function, construction of genomics/ cDNA libraries. Restriction enzymes. Restriction mapping- concept and techniques. DNA sequencing, PCR, Northern and Southern blotting, RFLP, RAPD, AFLP based DNA finger printing. Integration and expression of foreign genes in pro- and eukaryotes. Site-directed mutagenesis.

Unit-IV Credit hours: 12

Genetic Engineering of Plants: Methods of direct and *Agrobacterium* mediated gene transfer, electroporation, microinjection, particle-gun technology. CRISPR technology. Chloroplast transformation and its utility. Transgenic plants –Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance, stress tolerance, Golden rice and transgenic sweet potato. Current status of transgenic plants in India and other countries, ecological and ethical issues associated with GM crops and GM food.

Unit-VCredit hours: 12

Applications of plant genetic engineering: Biosensors, Biochips, Hybridoma technology, production of edible vaccines and antibiotics using transgenic technology, Terminator gene technology. Environmental impact of herbicide resistance crops and super weeds.

Intellectual Property Rights: Introduction to Intellectual Property. Historical Perspective, Different Types of IP, Importance of protecting IP. Copyrights, Trade Marks, Patents, Geographical Indications, Trade Secrets, Different International agreements; Word Trade Organization (WTO), General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS).

Practicals:

1. Explant preparation.
2. Medium preparation.
3. Shoot culture technique and regeneration.
4. Separation of shoots in organized culture.
5. In vitro and ex vitro rooting, hardening and acclimatization.
6. Isolation of plant genomic DNA, its purification and visualization.
7. Isolation of plasmid DNA and genetic transformation of bacterial cells using competent *E. coli*.
8. Preparation of master-mix and setting of PCR reaction.
9. RAPD and ISSR markers.
10. Demonstration of particle gun technology and model.
11. SDS-PAGE and its use in protein profiling and analysis.
12. Culture of *Agrobacterium tumefaciens* on agar-plate and broth.
13. Co-culture of *Agrobacterium* with plant explants.
14. Gus assay for genetic transformation.
15. Restriction Digestion of genomic DNA by use of Restriction enzymes e.g. Eco RI, Hind III, Bam H I and Gel Electrophoresis.

Reference Books:

1. Glick and Pasternick, J.J. Molecular Biotechnology, Principles and Applications of Recombinant DNA. Ason Press Washington.
2. Thieman,W.J. and Palladino, M.A. Introduction to biotechnology (II Edn). Pearson Publishing House.
3. Jeremy W Dale, Malcolm von Schantz . From genes to genomes. John Wiley and Sons Ltd.
4. Higgs, Paul,G. and Attwood, Teressa,K. Bioinformatics and molecular evolution. Blackwell Publishing.
5. Singh, B.D. Biotechnology- An Expanding Horizon. Kalyani Publishers.
6. Sandhya Mitra. Genetic engineering- principles and practice. Macmillan India Limited
7. Satyanarayana, U. Biotechnology. Books and Allied Publishers.
8. Primrose, S and Twyman R, Principles of Gene Manipulation and Genomics. Blackwell publishing.
9. Sambrook, J. and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL.

10. Brown, TA, Gene Cloning and DNA Analysis: An Introduction. Blackwell publishing.
11. Dale and Schantz. From genes to genome. Blackwell publishers.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –IV

M4BOT02-CT12	TOOLS AND TECHNIQUES IN PLANT SCIENCES

Unit-I Credit hours: 12

Microscopy: Optical, phase contrast, Fluorescence and electron microscopy (TEM and SEM), Confocal microscopy.
Centrifugation-Principle; Ultra centrifugation.
Electrophoretic techniques: Principle, types – Agarose Gel Electrophoresis, Native PAGE, SDS-PAGE, 2-D Gel Electrophoresis.

Unit-II Credit hours: 12

Chromatography:Principle and methodology of chromatographic techniques: (a) Paper (b) Thin Layer (c) Column (d) Gel (e) Gas and (f) HPLC.
Spectrophotometry-Principle, and applications, Atomic Absorption Spectrometer, NMR.

Unit-III Credit hours: 12

Bioinformatics: Introduction, BLAST, Biological Sequence Databases; nucleic acid and protein databases, Applications of Bioinformatics. Introduction to phylogenetics.
In situ hybridization: FISH, McFISH and GISH.
Introduction to Nanobiotechnology

Unit-IV Credit hours: 12

Biostatistics: Concept of treatment, replicates, sample and experimental design, Measures of central tendency – Mean (arithmetic), Median and Mode. Standard deviation and standard errors; skewness and kurtosis.

Unit-V Credit hours: 12

Biostatistics: Basics of Correlation and Regression. Analysis of variance (single factor analysis), chi-square test, Duncans multiple range test (DMRT).

Practicals:

1. Principle, construction, operation and application of the following instruments and technologies:
    (i) Various types of chromatography and TLC, column chromatography, gas and HPLC.
    (ii) Electrophoresis system
    (iii) Various types of microscopes.
    (iv) Centrifugation
    (v) Spectrophotometers
    (vi) Fluorimeters.
2. Computation of mean, mode, median, standard deviation, chi square, analysis of variance, correlation coefficient, regression analysis, post hoc analysis.
3. Multiple Sequence alignment and Construction of phylogenetic tree.

Reference Books:

1. Instrumental methods of chemical analysis: Chatwal and Anand, Himalaya Publishing House.
2. Instrumental Methods of Chemical Analysis: B.K. Sharma, Goel Publishing House.
3. S. C. Gupta. Fundamentals of Statistics. Himalaya Pub. House.
4. J. Medhi. Statistical Methods an introductory text. New Age International (P) Ltd. Publishers.
5. P. S. S. Sudar Rao & J. Richard. An introduction to biostatistics. Prentice Hall of India. N. Delhi.
6. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
7. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Elective

M3BOT03-ET01-A	BIOSYSTEMATICS–I

Unit-I **Credit hours: 12**

Systematic: Components, major objectives, Relevance to society and science. Taxonomic history. Cladistics, Phyletic and Phenetics systems of classification.

Unit-II **Credit hours: 12**

Nomenclature: Brief history of the origin and development of nomenclature; major provisions of the International Code of Nomenclature (ICN); Major changes from the preceding code.

Unit-III **Credit hours: 12**

Botanical nomenclature: Principles and rules, author citation, valid publications, rejecting the names, priority, and its limitation; type method, naming of new species, lagitimation.

Unit-IV **Credit hours: 12**

Classification: Components of classification; characters and their status; sources of characters. Classification of Robert F. Thorne (1968), RMT Dahlgren (1980), Arther Cronquist (1988) and Armer Takhtajan (2009).

Unit-V **Credit hours: 12**

Introduction to angiosperms: General characters; Evolutionary history; Basal angiosperms and Magnoliids; Basal monocots and Petaloid monocots.

Practicals

1. Study of at least 10 locally available families of flowering plants.
2. Description and identification of plants of following families at genus and species levels using flora-
    - **Basal angiosperms and Magnoliids:** Nymphaeaceae, Magnoliaceae.
    - **Basal Monocots:** Araceae, Alistamaceae,
    - **Petaloids monocots:** Liliaceae, Smilaceae, Alliaceae and Orchidaceae.

3. Identification of plants at genus and species level of locally available wild and medicinal plants.
4. Classification exercise based on APG system.
5. Exercise based on nomenclatural citations to solve nomenclatural problems.
6. Field trips in and around Udaipur, compilation of field notes and preparation of herbarium sheets of 25 plants.

Suggested Readings:

1. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.

2. Crawford, D.J. (2003). Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.

3. Cronquist, A. (1981). An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.

4. Hollingsworth, P.M., Bateman, R.M. and Gornall, R.J. (1999). Molecular Systematics of Plant Evolution Taylor and Francis, London.

5. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2008). Plant Systematics- A Phylogenetic Approach. Sinaner Associates Inc, Massachusetts, USA.

6. Simpson, M.C. (2006). Plant Systematics. Elsevier, Amsterdam. 7. Stussy, T.F. 1990. Plant Taxonomy, Columbia University Press, USA.

7. Scott-Ram N.R.(1990). Tranformed Cladistics, Taxonomy and evolution. Cambridge UniversityPress.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Elective

M4BOT03-ET03-A	BIOSYSTEMATICS–II

Unit-I **Credit hours: 12**

Plant collection and specimen preparation: Field inventorisation, collection, identification preparation, preservation and handling of herbarium, major herbaria in India and the world; role of herbaria in taxonomy.

Unit-II **Credit hours: 12**

Documentation and taxonomic literature: Flora, Monographs, Reviews, Diagnosis and descriptions; Rivision, Synopsis, Manuals, Icons and Journals.

Unit-III **Credit hours: 12**

Problems in evolutionary taxonomy: Concept of primitive and advanced characters/groups, monophyly and polyphyly, parallelism and convergence, homology and analogy.

Unit-IV **Credit hours: 12**

Modern trends in plant taxonomy: Numerical taxonomy, Phenetics and cladistics; Cladistics methodology, molecular taxonomy; chemotaxonomy, Brief account of DNA bar-coding in plants.

Unit-V **Credit hours: 12**

Introduction to angiosperms: General characters, evolutionary history; Commelinidis; basal eucots and Carryophylids; Rosids and Asterids.

Practicals:

1. Description and identification of plants of following families at genus and species levels using flora-

- **Commelinids:** Arecaceae, Poaceae, Cyperaceae.
- **Rosids:** Euphorbiaceae, Rosaceae, Fabaceae and Cucurbitaceae.
- **Asterids:** Solanaceae, Lamiaceae, Apiaceae and Asteraceae**.**

2. Cladograms construction and analysis.

3. Techniques of preparing herbarium sheets and its management.

4. Collection and identification of at least 25 plants belonging to different families. Prepare herbarium sheets and digitize it.

Suggested Readings:

1. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Gurucharan Singh (2010). Plant Systematics: An Integrative Approach. Science Publisher, Enfield, NH, USA.
3. Harris, J.G. and Harris, M.W. (2001). Plant identification terminology: An illustrated Glossory. Spring Lake Publisher.
4. Nei, M. and S. Kumar (2000). Molecular Evolution and Phyllogenetics. Oxford University Press, New York.
5. Semple, l. and Steel, M.A. (2003). Phyllogenetics. Oxford University Press, Oxford.
6. Simpson, M.G.(2006). Plant Systematics. Elsevier, Amsterdam.
7. Stuessy, T.F. (2006). Plant taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press New York.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Elective

M3BOT03-ET01-B	PRINCIPLES OF PATHOLOGY AND PLANT DISEASES

Unit-I Credit hours: 12

Disease: History of plant pathology, Concept of disease: Parasites, parasitism, pathogen and pathogenicity. Types and classification of diseases, factors affecting plant diseases, detailed study of epidemics and epiphytotics, Isolation and identification of plant pathogens, Koch's Postulates, Disease forecasting.

Unit-II Credit hours: 12

Pathogenesis: Inoculum potential and source, pre-penetration, penetration and post penetration events, , disease transmission, deranged physiology, Variability in pathogen, pathogenicity genes and virulence factors, enzymes, PGRs, polysaccharides and toxins, preformed defence barriers.

Unit –III Credit hours: 12

General account of **fungal diseases**, symptoms etiology and control of:damping off of seedlings, rhizome rots of ginger, late blight of potato and tomato, downy mildew of maize, potato wart, powdery mildew of wheat, stem galls of coriander, ergot of bajra**,** early blight of potato and tomato, leaf spot caused by *Alternaria* on crucifers, tikka disease of groundnut, *Helminthosporium* leaf spot of Rice; Blast of Rice, Red rot of sugarcane, Die back of chili, Wilt of Pigeaon pea, *Rhizoctonia* stem rot of crops**.** loose smut and Bunt of wheat, karnel bunt of Rice, head and grain smut of Jowar, whip smut of sugarcane. Rust of wheat and Bajra.

Unit-IV Credit hours: 12

General account of symptoms, etiology of **Bacterial diseases:** Angular leaf spot of cotton, citrus canker, Gummosis of sugarcane, bacterial wilt of solanaceous vegetables, blight of bean, Soft rots of fruits, ratoon stunting of sugarcane **Phytoplasma and spiroplasma diseases:** Symptoms and disease cycle of little leaf of brinjal, Sesamum phylody, witches broom diseases, Grassy shoot of sugarcane **Viruses and Viroid diseases**: Papaya leaf curl, Bunchy top of Banana, Rice Tungro, Bud necrosis of Groundnut, Bean common mosaic, Potato spindle tuber, coconut cadang-cadang.

Unit-V Credit hours: 12

Parasitic diseases : *Striga, Cuscuta, Orobanche*. Nematode disease - Root knot of tomato caused by *Meloidogyne* and ear cockle disease of wheat. Classification and anatomy of galls. Some insect induced plant galls of Rajasthan (*Pongamia* leaf galls, *Cordia* leaf galls, *Ziziphus* stem galls, *Prosopis* stem galls), mechanism and physiology of insect galls. **Non parasitic diseases:** Nutritional deficiencies, Blossom rot of tomato, mango black tip, zinc deficiency of citrus. Effects of pollutants: Ozone, PAN (Peroxyacyl nitrate), Sulfur di oxide and Hydrogen fluoride.

Practicals:

1. Preparation of culture media; PDA, Czapeks Dox Agar and Fries' medium for fungal culture.
2. Measurement of fungal dimensions (Measurement of spore size, Mycelium width etc.)
3. Proving of Koch's postulates for at least one fungal disease and one bacterial disease.
4. Isolation of nematode from soil & study of their histology.
5. Study of diseases with respect to host, casual organism, symptoms.
6. Isolation and pure culture development of plant pathogenic fungi and bacteria.
7. Identification of plant pathogenic fungi and bacteria.
8. Calculation of spore count using Haemocytometer
9. Measurement of plant diseases- Disease scoring.
10. Study of galls and their histology.
11. Biochemical analysis of healthy and diseased plant materials to detect changes in proteins, sugars, enzymes, hormones and secondary metabolites.

Reference Books:

1. Principles of Plant Pathology, R.S. Singh, 3 rd Ed., Oxford & IBH Co., New Delhi. 1988.
2. Plant Pathology, R.S. Mehrotra,. Tata McGraw Hill Publishing Company, New Delhi. 1989.
3. Diseases of Crop Plants in India, G. Rangaswami and A. Mahadevan, Printice Hall of India Publications. 1999.
4. Essential Plant Pathology, Gail L. Schumann and Cleora J. D'Arcy C H Dickinson , J A Lucas, 2006.
5. A Text books of Modern Plant Pathology, K. S. Bilgrami and H. C. Dube, Vikas Publishing House Pvt. Ltd., 1996.
6. Plant Tumors, Arun Mishra, Today and Tomorrow's Printer and Publishers, India, 1985.
7. Plant Disease: An Advance Treatise, James G. Horsfall and Ellis B. Cowling, Second Edition, Academic Press, London, 1977

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Elective

M4BOT03-ET03-B	MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT

Unit-I Credit hours: 12

Resistance to plant pathogens: Types and classification of plant resistance, Elicitor-Receptor concept (PTI, ETI etc), role of signal transduction in disease, induced defence responses, Local resistance (HR), systemic acquired resistance, programmed cell death (PCD), signaling molecules (types and functions), PR proteins, phytoalexins, ISR and plantibodies. Gene-for-gene concept, avr and R genes, co-evolution of R gene.

Unit –II Credit hours: 12

Disease diagnosis by serological and molecular methods, sensors, Information Technology in Plant Pathology, Plant disease clinics, use of database and application of Bioinformatics in plant pathology- a general account. GIS and Remote sensing in plant pathology. Mile stones in plant pathology with particular reference to India. Institutes of repute of plant pathology in India and abroad.

Unit –III Credit hours: 12

Plant disease management: Concept: Principles and practice, Prophylactic approach, Eradication, Prevention. Quarantine and Quarantine restrictions. Case studies of exotic pests/diseases introduced with special reference to India. Chemical control; classification and types of formulations, additives, application, equipment, and calibrations transportation, handling, storage and disposals. Bioassay tests and formulation stability. Resistance to chemicals.

Unit- IV Credit hours: 12

Biological control: Definition, Concept, biological control agents (BCA), natural control and natural balance. Types of interactions contributing to biological control. Mechanisms of biological control. Commercial products and application, Integrated Disease management- General account (importance and basic principles).

Unit- V Credit hours: 12

Breeding for disease resistance, marker assisted, in vitro methods, Transgenics: Coat protein mediated resistance (CPMR), antisense and gene silencing. Candidate genes to combat microbial pathogens (Chitinase,Thionine, Permatins, Lysozymes and Lectins),

Ribosome inactivating proteins-RIPs, plantibodies and enhanced secondary metabolite production.

Practicals

1. Study of the effect of fungicides on the germination and growth of plant pathogenic fungi.
2. Raising virus free plants in culture (meristem tip culture)
3. Identification of microbes in deteriorated materials viz. vegetables, fruits etc.
4. Antibiotic sensitivity test.
5. Detection of Seed borne pathogens by- i) Washing test ii) Incubation method iii) Blotter method iv) Agar plate method
6. Qualitative estimation of Mycotoxins by Paper Chromatographic method
7. Isolation and separation of pathogenic fungal nucleic acids.
8. Amplificaiton of Fungal DNA by PCR

Reference Books:

1. Principles of Plant Pathology, R.S. Singh, 3 rd Ed., Oxford & IBH Co., New Delhi. 1988.
2. Plant Pathology, R.S. Mehrotra,. Tata McGraw Hill Publishing Company, New Delhi. 1989.
3. Diseases of Crop Plants in India, G. Rangaswami and A. Mahadevan, Printice Hall of India Publications. 1999.
4. Essential Plant Pathology, Gail L. Schumann and Cleora J. D'Arcy C H Dickinson , J A Lucas, 2006.
5. A Text books of Modern Plant Pathology, K. S. Bilgrami and H. C. Dube, Vikas Publishing House Pvt. Ltd., 1996.
6. Plant Tumors, Arun Mishra, Today and Tomorrow's Printer and Publishers, India, 1985.
7. Plant Disease: An Advance Treatise, James G. Horsfall and Ellis B. Cowling, Second Edition, Academic Press, London, 1977

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M3BOT03-ET01-C	BIOLOGY AND EVOLUTION IN BRYOPHYTES-I

Unit-I Credit hours: 12

Introduction, characteristic features and classification. Evolution of gametophytes and sporophytes. Reproduction- asexual and sexual.

Unit –II Credit hours: 12

A comparative study of the various orders of - Hepaticopsida, Anthocerotopsida, Bryopsida, Regeneration studies, Ecology.

Unit –III Credit hours: 12

Bryophyte flora of Rajasthan, Contribution of Indian Bryologists : SR Kashyap, SK Pande, Ram Udar, PN Mehra, Cytology and cytogenetics. Spore morphology, germination and interrelationships in mosses.

Unit –IV Credit hours: 12

Morphogenetic studies with special reference to - Protonema and mechanism of bud formation

Physiology of rhizoid formation, Physiology of reproduction

Unit –V Credit hours: 12

Origin of Bryophytes, Economic importance, Micro techniques in bryological studies

Practicals:

1. Collection, identification and morphotaxonomical study of at least 20 bryophytes from Udaipur region and deposit to the Department.
2. Morphotaxoanatomical study of -*Marchantia, Plagiochasma, Asterella, Targionia, Lunularai, Rebaulia, Porella, Anthoceros, Notothylus, Polytrichum, Pogonatum, Sphagnum*.

Reference Books

1. Rashid, A. (1998). An introduction to Bryophyta. Vikas PublicationsHouse Pvt. Ltd. New Delhi.
2. Watson. E.V.(1991). British Mosses and Liverworts.Cambridge University Press.
3. Smith, G.M (1955). Cryptogrmic Botany. Vol. II.McGraw Hill Book Company.

4. Kashyap, S.R. (1929).Liverworts of the Western Himalayas and the Punjab Palm Part I.
University of Punjab Lahore.
5. Goffinet, B.and Vanderpoorten, A. (2009). Introduction to bryophytes. Cambridge University Press.

6. Puri, Prem. (1973). Bryophytes: A broad perspective.1973. Atma Ram and Sons.

7. Puri, Prem (1981). Bryophytes: Morphology, Growth and Differentiation. Atma Ram and Sons.

8. Parihar, N.S. (1961).Bryophyta. Vol.I. Central Book Depot.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M4BOT03-ET03-C	BIOLOGY AND EVOLUTION IN BRYOPHYTES-II

Unit-I **Credit hours: 12**

Alternative pathways in the life cycles of bryophytes: Apogamy-Occurrence of Apogamy in diplophase and haplophase, Spore production in apogamous sporophytes, Factors controlling of apogamous sporophytes; Apospory-Occurrence of Apospory, callus formation and regulatory factors in differentiation of aposporous gametophytes.

Unit-II **Credit hours: 12**

Photomorphogenesis: Spore germination, protonemal differentiation, Growth and vegetative propagation in liverworts and mosses. Bud induction in mosses; Factors controlling bud induction in bryophytes.

Unit-III **Credit hours: 12**

Bryophytes as indicators of pollution: Heavy metals-Lead, Cadmium, Copper and Zinc; Stability patterns of metal ions; metal tolerance-Copper mosses; Gaseous pollutants-Sulphur dioxide, Fluorides and Ozone.

Unit-IV **Credit hours: 12**

Conduction in bryophytes: External conduction- Gametophyte, Sporophyte; Significance of external conduction; Internal conduction- Cells involved in internal conduction, Conducting strands in seta and capsule, conduction of water and organic compounds.

Unit-V **Credit hours: 12**

Model bryophytes: *Tortulla muralis*-Morpho taxonomy, draught and stress tolerance; *Physcomitriella patens*-Morpho taxonomy, model plant to solve Phylogenetic relationship problem among archegoniate.

Practicals:

1. Culture media preparation-half Knof's, Full Knof's and MS.

2. Sterilization and culture techniques of explants.

3. *In vitro* spore germination techniques.

4. In vitro study of protonemal differentiation and bud formation.

5. In vitro study on effect of heavy metals on regeneration.

6. In vitro culture of explants for gametophore formation.

Reference books

1. Schofield, W.B.(1985). Introduction to Bryology. 2nd Edition, British Press. Columbia.
2. Chopra, R.N. and Bhatia, S.C. (1990).Bryophyte Development: Physiology and Biochemistry.
CRC Press New Dehli.
3. Chopra, R.N. and Kumra, P.K. (1988). Biology of Bryophytes. Willy Eastern Limited, New Dehli.

4. Goffinet, Bernard (2000). Bryophyte Biology. Cambridge University Press.

5. Jonathan Shaw, A.(2011). Bryophyte biology. Cambridge Press.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M3BOT03-ET01-D	RESTORATION ECOLOGY

Unit-I Credit hours: 12

Species and habitat management: Prioritizing, criteria for choices of species for conservation with hotspots of global biodiversity, protected area networks, the theory of reserve design, managing access to protected areas.

Unit-II Credit hours: 12

Managing exploitation: Human population growth and resource exploitation trends, determining sustainable yields through models, controlling exploitation.

Ecology of disturbed ecosystems: Disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems.

Unit-III Credit hours: 12

Aims and strategies of restoration: Concepts of restoration, single vs. multiple end-points, ecosystem reconstruction, physical, chemical, biological and biotechnological tools of restoration. Restoration of biological diversity: Acceleration of ecological succession, reintroduction of biota.

Unit-IV Credit hours: 12

Degradation and restoration of natural ecosystems: Forests, grasslands/ savanna, aquatic. Restoration of degraded soils: Restoration of contaminated soils and soil fertility, mine spoil restoration.

Unit-V Credit hours: 12

Introduction to Environmental Biotechnology, Environmental toxicants – Heavy metals, pesticides, their effects on human beings, Bioremediation, Biosensors, Biofuels, Metagenomics, Sustainable development, organic farming, nano-fungicides.

Practicals:

a. Genomic DNA isolation using modified CTAB method
b. Application of RAPD and ISSR markers for understanding genetic diversity
c. Band scoring, tree robustness, and tree preparation using various softwares

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M4BOT03-ET03-D	CONSERVATION BIOLOGY

Unit-I Credit hours: 12

Population dynamics and conservation: Genetic variation and its loss, variation in natural populations, mechanism of population regulation, habitat specific demography, population viability analysis.

Unit-II Credit hours: 12

Life history patterns, Concept of Population Genetics (Hardy–Weinberg principle). Inbreeding and outbreeding, Effective population size, Genetic drift in small population, bottlenecks and founder events, Speciation types. Adaptive radiation

Unit-III Credit hours: 12

Conservation genetics; Genetic markers used in conservation biology, phenotypic plasticity, Genetic differentiation and gene flow

Unit-IV Credit hours: 12

Some case studies of conservation genetics on endangered plant species, analysis of molecular variance, mantel test

Unit-V Credit hours: 12

Conservation planning: The planning process, the species action plan process, the site management plan process. Concept of Niche conservation.

Practicals:

a. Operation of softwares related population genetic analysis like POPGENE
b. Understanding within and among population genetic diversity using Arlequin
c. Understanding correlation between genetic diversity and distance using Mantels test.

Suggested readings:

1 Beebee Trevor J. C., Rowe Graham 2008 An introduction to molecular ecology 2.ed.: Oxford : Oxford University Press, ISBN: 978-0-19-929205-9

2 Conservation Biology **(CB)** (1996) edited by I.F. Spellberg.

3 Biodiversity I **(B1)** (1988): understanding and protecting our biological resources. Edited by M. L. Reaka-Kudla, D. E. Wilson, and E. O. Wilson.

4 Biodiversity II **(B2)** (1997): understanding and protecting our biological resources. Edited by M. L. Reaka-Kudla, D. E. Wilson, and E. O. Wilson. (available online as an e-book at the university library).

5 Future of Life **(FL)** (2002) by E. O. Wilson.

6 JC Avise 2004. Molecular Markers, Natural History and Evolution. Sinauer Associates.

7 RDM Page and EC Holmes 1998. Molecular Evolution: A Phylogenetic Approach, Blackwell Science Ltd.

8 JR Freeland 2005. Molecular Ecology, John Wiley & Sons, Ltd.

9 A Lowe, S Harris and P Ashton 2004. Ecological Genetics: Design, Analysis and Applications. Blackwell Publishing.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M3BOT04-ET02-A	PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY

Unit-1 Credit hours: 12

Bioenergetics of Photosynthesis: Ultrastructure and functions of Photosystem I, Photosyntem II and F_1F_0 ATP synthase; Oxygen evolving complex, Molecular mechanism of ATP biosynthesis, RuBisCO and PEP Carboxylase- structure and function; Regulation of photosynthesis in C3, C4 and CAM pathways.
Artificial Photosynthesis: solar fuels, hydrogen production.

Unit-II Credit hours: 12

Chlorophyll fluorescence: General concept, Kautsky effect- Polyphasic fluorescence transients, JIP-test, fluorescence parameters- minimal fluorescence (Fo) to maximal fluorescence (Fm), quantum yield of photosynthesis (Fv/Fm), specific and phenomenological fluxes.

Unit-III Credit hours: 12

Carbohydrate metabolism and regulation: Energetics of glycolysis, gluconeogenesis, regulation of glycolysis and gluconeogenesis, HMP shunt, Uronic acid pathway, Cori's cycle, Glyoxalate pathway.
Fatty acid metabolism and regulation: Biosynthesis of saturated & unsaturated fatty acids, Regulation of fatty acid metabolism, Alpha, Beta & Omega oxidation. Ketogenesis, Metabolism of triacyl glycerols.

Unit-IV Credit hours: 12

Amino acid metabolism and regulation: Reductive amination, GS-GOGAT pathway, transamination, regulation of amino acid metabolism.

Proteins: various conformations, plot, protein degradation- Ubiquitin/Proteasome Pathway.

Unit-V Credit hours: 12

Abiotic and Biotic stress: Osmotic stress: Molecular basis of drought and salinity resistance. Heat stress: Heat shock proteins and their role in stress resistance; Cold stress: molecular basis of freezing injury and tolerance; Mechanism of heavy metal tolerance;

Role of secondary metabolites in biotic stresss tolerance: NO, Benzoic acid, salicylic acid, Jasmonic acid. Brassionosteroids, Pathogenesis-related (PR) proteins, Plant defensins, Pytoalexins, Systemic plant defence responses, Systemic acquired resistance (SAR), Induced systemic resistance (ISR).

Practical

1. Demonstration of stomatal physiology in C3, C4 and CAM plants.
2. Demonstration of chlorophyll fluorescence in plants.
3. Demonstration of oxygen evolution during photosynthesis.
4. Determine proline content in stressed and unstressed plants.
5. Determine catalase activityt in stressed and unstressed plants.
6. Determine SOD activity in stressed and unstressed plants.
7. Determination of total phenol and PPO activity.
8. Determine chlorophyll contents in stressed and unstressed plants.

Reference Books

11. Plant Physiology; Lincoln Taiz and Eduardo Zeiger, Sinauer Associates; 3rd ed. 2002.
12. Introduction to Plant Physiology; William G. Hopkins and Norman P. A. Huner. Wiley; 3 Ed., 2003.
13. Plant Physiology; Frank B. Salisbury and Cleon Ross. Brooks Cole; 4th edition 1992.
14. Water Relations of Plants, Paul Jackson Kramer. Academic Press. May 1983.
15. Plant Stress Biology: From Genomics to Systems Biology. Wiley-VCH, 2009.
16. Plant Abiotic Stress (Biological Sciences Series); Eds: Matthew A. Jenks and Paul M. Hasegawa. Wiley-Blackwell, 2005.
17. Plant Physiology; Eds; Meirion Thomas. Prentice Hall Press; 5th edition. 1973.
18. Physiology and Molecular Biology of Stress Tolerance in Plants; Eds; K.V. Madhava Rao, A.S. Raghavendra and K. Janardhan Reddy. Springer; 1st edition, 2006.
19. Oxidative Stress in Plants; Dirk Inze and Marc Van Montagu. CRC Press; 1st edition, 2001. Antioxidants and Reactive Oxygen Species in Plants (Biological Sciences Series). Ed; Nicholas Smirnoff. Wiley-Blackwell. 2005.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M4BOT04-ET04-A	SECONDARY METABOLITES AND BIOPROCESS ENGINEERING

Unit-I Credit hours: 12

Secondary metabolites: Primary and secondary metabolites. Principal classes of secondary metabolites with their occurrence and classification: Alkaloids, Terpenes and Phenolics. Shikimic acid and mevalonate pathways. Bioactive molecules from fungi (Fungal metabolites, Mycotoxins, colorant, enzymes) and Microorganisms (Enzymes, Proteins)

Unit-II Credit hours: 12

Production of secondary metabolites: Basic concept of Callus and cell suspension cultures. Nutrients and media, approaches and factors affecting the production of secondary metabolites (optimization, effects of auxin, selection, hairy roots, elicitation, precursors, concept of growth and production media). Basic concepts of Biotransformations and Cell Immobilization. General methods of extraction, isolation and identification of Alkaloids, terpenes and phenolics

Unit-III Credit hours: 12

Bioprocess engineering: Concept of Bioprocess engineering, Types of bioreactors (stirred tank, air lift, membrane type, immobilized cell and wave bioreactors), process (batch, fed-batch, semi-continuous and continuous), operation and downstream processing for bioreactors. Bioreactors for production of biomass. Plant tissue culture industry in India.

Unit-IV Credit hours: 12

Production of pharmaceutically important drugs in culture: Alkaloids (*Catharanthus, Nicotiana, Papaver*), anti-tumour agents (taxol, podophyllotoxins, camptothecine), saponins and sterols (diosgenin, guggul, ginseng), food additives (sweetners, flavours and colours). mi RNA based regulation of secondary metabolite biosynthesis in plants. Future perceptive of Drug discoveries from Medicinal Plants. Basic concepts of nanomedicines.

Unit-V Credit hours: 12

Molecular farming: Production of drugs and recombinant protein by genetic engineering technology, metabolic engineering for the production of useful metabolites (Pathway manipulation of Tropane and Indole alkaloids), Edible vaccines, products on market, Production of Artemisinin by genetically modified microbes. Basic concepts of functional foods. Nutraceuticals (Classification of Nutraceuticals, Phytochemicals as nutraceuticals).

Practicals:

1. Extraction and preparation of crude extract for value addition.
2. TLC and/or Paper Chromatography of various compounds – alkaloids, food additives.
3. Handling of spectrophotometer and _λ_max determination and study of some advance analytical instruments/techniques.
4. HPLC profiling of Selected Plant material: separation of secondary products, preparation of samples for HPLC (dilutions, filtration by membrane, loading and calculation of data).
5. Column chromatography for isolation of pure compound.
6. Identification of 10 local medicinal plants and their usage.
7. Quantitative tests for alkaloids, steroids, terpens, phenolics etc.
8. Media preparation for callus and Cell Suspension culture.
9. Initiation of callus and cell suspension culture.
10. Initiation of Hairy Root cultures for secondary metabolites production.
11. Designing of scale up experiments using Bioreactor for cell suspension and Hairy root culture.
12. Chemical diversity analysis and correlation with genetic diversity of that plant.
13. Media preparation for fungal cultures.
14. Isolation, culture and Identification of some important fungi for metabolite production.
15. Visit to pharmaceutical/drug/ Natural product producing industry.
16. Market survey for availability of various functional food and Neutraceuticals

Reference Books:

1. Plant Secondary Metabolites by A. Crozier et al., Blackwell Publishers.
2. Biotechnology – Secondary Metabolites by K.G. Ramawat & J.M. Merillon, Science Publishers Inc.

3. Natural Products from Plant II Edition by L.J. Cseke et. al., Taylor and Francis.
4. Bioactive Molecules and Medicinal Plants by K.G. Ramawat and J.M. Merillon, Springer, Germany.
5. Plant-derived Natural Products by A.E. Osbourn & V. Lonzotti, Springer, Germany.
6. Handbook of Secondary Fungal Metabolites by Richard J. Cole, Bruce B. Jarvis and Milbra A. Schweikert. 2003 Elsevier Inc.
7. Fungal Metabolite by Merillon JM, Ramawat KG.2017.. Springer, Switzerland.
8. Protective Cultures, Antimicrobial Metabolites and Bacteriophages for Food and Beverage Biopreservation (Woodhead Publishing Series in Food Science, Technology and Nutrition) Hardcover – Import, 29 Nov 2010 by C. Lacroix MD. Publisher: Woodhead Publishing (29 November 2010) ISBN-10: 1845696697
9. Market Overview of Nutraceuticals in India : The complete report of Functional Foods, Probiotics and Dietary Supplements in India Kindle Edition by Atharva Lifesciences Consulting. Publisher: Atharva Lifesciences Consulting Pvt. Ltd. (19 August 2013) ASIN: B00EOLOQTC
10. Handbook of Nutraceuticals: Volume I, Ingredients, Formulations And Applications (Special Indian Edition) Hardcover – 2016 by Yashwant Pathak. Publisher: T&F India (2016). ISBN-10: 1498770886

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Elective

M3BOT04-ET02-B	PRINCIPLES OF MICROBIAL TECHNOLOGY

Unit-I Credit hours: 12

Industrial Biotechnology: Principles of fermentation technology, Fermenters and Bioreactors; types, construction, design. Operation processes; aeration, agitation, temperature regulation and filtration method. Control of bioprocess parameters; physical, chemical and mechanical.

Unit-II Credit hours: 12

Fermentation processes: Isolation, purification and establishment of pure culture of microorganisms; major types of cultures – batch, continuous and synchronous. Solid state fermentation. Air and Media sterilization. Microbial growth kinetics and measurement of growth. Factors affecting growth. Media for industrial fermentation. Inoculum development.

Unit-III Credit hours: 12

Preservation and improvement of industrially important microbes. Strain selection and improvement, mutation - protoplast fusion, parasexual reproduction and recombinant DNA technique for strain development.

Unit-IV Credit hours: 12

Downstream Processing: introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization. Quality control and evaluation of industrial products.

Unit-V Credit hours: 12

Fermentation of microbial products – Single Cell Protein (SCP). Anaerobic fermentation (beer and wine). Aerobic fermentation (vinegar and citric acid). Antibiotic fermentation (penicillin and streptomycin). Vitamins (B12, riboflavin), Hormone (gibberellic acid, IAA). Enzyme (amylase, protease). Biogas production.

Practicals III Semester:

1. Study of principle and working of important instruments used in industrial and bioprocess engineering.
2. Study of growth kinetics of bacteria.
3. Study of effect of physical factors on growth of production strain.
4. Study of effect of chemical factors on growth of production strain.
5. Study of effect of inoculum size on growth.
6. Study of effect of UV radiation on microbial growth.
7. Study of effect of chemical disinfectants on microbial growth.
8. Isolation and purification of microbial metabolites
9. Study of production of organic acids from bacterial strains.
10. Study of immobilization of enzymes.
11. Isolation of antibiotic producing microbes from soil.
12. Antibiotic sensitivity test.
13. Isolation of industrially important microorganisms for microbial processes.
14. To test the production of enzymes: Amylase, proteinases, lipases and celluloses by microorganisms.
15. Demonstration of citric acid production by *Aspergillus niger*.
16. Determination of phenol coefficient.

Reference books:

1. Microbiology: Concepts and Applications; Michael Joseph Pelczar, E. C. S. Chan, Noel R. Krieg, McGraw-Hill Companies; 6th edition (February 1993).
2. General Microbiology; R.C. Dube and D. K. Maheswari. S Chand , New Delhi. 2000.
3. Microbiology; M.J., Prescott, J.P Harley and D.A. Klein.. 5^{th} Edition, WCB Mc GrawHill, New York. 2002.
4. General Microbiology; R.Y. Stanier, E.A. Adelberg and J.L. Ingram. 5th Ed., Prentice Hall of India Pvt. Ltd., New Delhi. 1991.
5. Introduction to Microbiology; A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
6. Microbiology: Principles and Explorations, J.G. Black, John Wiley, USA.2005.
7. A Text Book of Microbiology: R. C. Dubey and Maheshwari. S Chand & Company Ltd. 2009.
8. Principles of Fermentation Technology; P F Stanbury , S. Hall , A. Whitaker. Butterworth-Heinemann; 2 edition. 1999.
9. Microbiology: an Introduction, G.J. Tortora. R.F. Burdell and C.L. Case. Benjamin-Cummings Publishing Company. 1989.
10. Industrial Microbiology: An Introduction; M.J. Waites, N. L. Morgan, N. L. and G. Higton, Wiley-Blackwell. 2001.
11. Experiments in Microbiology, Plant pathology and Biotechnology, K. R. Aneja. New Age international Publishers, 2004.
12. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Elective

M4BOT04-ET04-B	APPLICATIONS OF MICROBIAL TECHNOLOGY

Unit-I Credit hours: 12

Agricultural Microbiology: Agriculturally important microorganisms; Biological nitrogen fixation (symbiotic association in root nodules); Cyanobacteria, Mycorrhizae, microbial mineralization, Microbial interactions between plants–phyllosphere, rhizosphere, Plant growth promoting rhizobacteria (PGPR). Biofertilizer- VAM, *Rhizobium, Frankia, Azospirillum, Azotobacter, cyanobacteria* and *Azolla*. Microbes used as biocontrol of plant diseases.

Unit-II Credit hours: 12

Environmental Microbiology: Microbes and quality of environment; Distribution and implications of microbes in air – bio-aerosols, stages of mineral water production. Analysis of water quality – pH, salinity, alkalinity, dissolved oxygen, carbonates, nitrate, silicate, phosphate, COD and BOD. Determination of microbial load in water, Methods of water quality assessment – MPN test, membrane filtration technique. Role of microbes in wastewater treatment with special reference to activated sludge.

Unit-III Credit hours: 12

Microbes in recovery of metal (bioleaching) and oil, Microbial pesticides, Biotransformations: microbial degradation of pesticides and toxic chemicals, biodegradation of the agricultural residues, bioremediation of contaminated soils and water. Microbes in nanotechnology, biosensors and their applications, Microbes for bio-energy and environments.

Unit-IV Credit hours: 12

Food Microbiology: Microorganisms and Food Spoilage, Factors Affecting the Growth and Survival of Micro-organisms in Foods, Food Safety, Microbiological Quality Assurance. Types of food spoilage, methods of food preservation. Microbiology and types of fermented foods: yogurt, acidophylous milk, dahi, cheese, other fermented foods: dosa, sauerkraut, pickles, soy souce. Probiotics: types, health benefits, probiotic food available in market.

Unit-V Credit hours: 12

Preservation of pharmaceutical products: Chemical preservatives – raw materials – equipment – role of preservatives. Finished product tests – microbial enumeration test, tests for specified microorganisms. Rapid methods for detection of microorganisms in food – conventional and automated. Quality control in fruits and vegetable processing.

Practicals IV Semester

1. Isolation of microbes from rhizosphere and rhizoplane.
2. Determination of BOD of waste-water sample.
3. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
4. Methylene blue reductase test to determine the quality of milk sample.
5. Study of food-spoilage microorganisms in fresh, canned, fermented food and meat.
6. Production and analysis of SCP: *Spirulina*, yeast, *Chlorella*, mushroom.
7. Production of yoghurt using specific starter cultures.
8. Preparation of alcohol from fruit juices.
9. Viable count of bacteria in milk.
10. Potability analysis of drinking water.
11. Isolation of *Rhizobium* from root nodule.

Reference books:

1. Food Microbiology; William C Frazier and Dennis C. Westhoff. Tata Mgraw Hill. 2008.
2. Microbiology; M.J., Prescott, J.P Harley and D.A. Klein.. 5th Edition, WCB Mc GrawHill, New York. 2002.
3. General Microbiology; R.Y. Stanier, E.A. Adelberg and J.L. Ingram. 5th Ed., Prentice Hall of India Pvt. Ltd., New Delhi. 1991.
4. Introduction to Microbiology; A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
5. A Text Book of Microbiology: R. C. Dubey and Maheshwari. S Chand & Company Ltd. 2009.
6. Experiments in Microbiology, Plant pathology and Biotechnology, K. R. Aneja. New Age international Publishers, 2004.
7. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007.
8. Adams, M.R. and Moss, M.O. 2008. Food Microbiology, RSC Publishing, Cambridge, UK.
9. Benwart, G.J. 1987. Basic Food Microbiology, CBS Publishers & Distributors, New Delhi.
10. Blackburn C. de W. 2006, Food spoilage microorganisms, Woodhead Publishing, Cambridge, UK
11. Deak, T. and Beuchat, L.R. 1996. Hand Book of Food Spoilage yeasts, CRC
12. Frazier, W.C., and Westhoff, D.C. 1988. Food Microbiology (Reprint 1995), Tata McGraw Hill Publishing Ltd., New Delhi.
13. Garbutt, J. 1997. Essentials of Food Microbiology, Arnold – International Students edition, London.
14. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons, Inc, New York.
15. Ashutosh Kar, 2008. Pharmaceutical Microbiology, New Age International Publishers,New Delhi.
16. Trivedy, R.K., Goel, P.K. and Trishal, C.L. 1987. Practical methods in Ecology and Environmental science. Environmental publishers.

17. Manivasakam, N. 2001. Chemical and Microbial analysis of mineral and packaged
drinking waters. Sakthi Book Service, Coimbatore.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M3BOT04-ET02-C	ADVANCED PHYCOLOGY

Unit –I Credit hours: 12

Methods of algal study; collection of algae, preservation, types of culture media, preparation of culture media, isolation, types of cultures, commercial cultivation of algae.

Unit –II Credit hours: 12

Algal taxonomy, morphological identification keys, molecular systematics, role of DNA barcoding genes, evolution of algal groups and phylogenetics. Fossil algae.

Unit –III Credit hours: 12

Molecular mechanisms of photodamage and photoprotection: Photo-induced damage to microbes; genetical, biochemical and molecular aspects of mycosporine-like amino acids (MAAs) and scytonemin production, ecological and economical implications.

Unit –IV Credit hours: 12

Light harvesting in Algae: Phycobilisomes, biochemical and molecular insight of light sensing and photomorphogenesis during complementary chromatic acclimation (CCA) in model organism *Fremyella diplosiphon*, ecological significance of CCA, model of CCA

Unit –V Credit hours: 12

Algal toxins: Types of toxins, molecular tools for the identification of toxic substances, biochemical and molecular aspects of toxin production, ecological and economical implications.

Practicals

1. Preparation of algal culture media
2. Collection, isolation and axenic culture establishment

3. Measurement of growth rate of algal culture
4. Extraction and purification of mycosporine-like amino acids (MAAs) from cyanobacteria
5. Spectrophotometric analyses of MAAs
6. Extraction and purification of scytonemin from cyanobacteria
7. Spectrophotometric analyses of scytonemin
8. Study of complementary chromatic acclimation (CCA) in cyanobacteria and extraction of photosynthetic pigments (chlorophyll, carotenoids and phycobiliproteins)
9. Spectrophotometric, FPLC and SDS-PAGE analyses of phycobiliproteins

Suggested Readings:

1. Lee RE (1989). Phycology. Vol. II. Cambridge Univ. Press. Cambridge, USA.
2. Sahoo D & Qasim SZ (Eds), (2002). "Sustainable Aquaculture". APH Publishing Corporation, New Delhi, India.
3. South GR and Whittick A. (1987). Introduction to Phycology. Blackwell Scientific Publications. London.
4. Journals: Journal of Applied Phycology, Journal of Phycology, European Journal of Phycology, Phycologia, Botanica Marina.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M4BOT04-ET04-C	APPLIED PHYCOLOGY

Unit –I Credit hours: 12

Algae for bioenergy; use of algae for biodiesel production, bio-ethanol and biological hydrogen production, technique of isolation of algal oil, characteristics of algal oil, fuel extraction, current status, economic viability and future prospect. Diatom based solar panels. Genetic engineering for production of biofuels (biodiesel, hydrogen production).

Unit –II Credit hours: 12

Optimization of production of useful high value compounds from algae, Case study of algae producing high value compounds like astaxanthin, omega-3 and -6, fucoxanthin, eicosapenenoic acid (EPA), dicosahexaenoic acid (DHA), alpha-linolenic acid (ALA), carrageenan, Agar, proteins, vitamins. Market value of high value compounds.

Unit –III Credit hours: 12

Application of algae for nanoparticles synthesis, characterization techniques of nanoparticles, current market for phyconanotechnology. Nanoecotoxicology; effect of nanoparticles on algal physiology.

Unit –IV Credit hours: 12

Application of algae for bioremediation of waste water containing heavy metals and organic pollutants, absorption and adsorption kinetics. Algae in global warming – carbon capture by algae. High-rate algal ponds for the treatment of wastewaters and for the production of useful biomass and energy, immobilized and inactivated algal biomass for metal and nutrient removal.

Unit –V Credit hours: 12

Synthetic biology of Algae: Introduction of synthetic biology, Genetic modification of Algae, inducible promoters, reporters, application of algal synthetic biology. Algae

as biofertilizers. Algal Bioplastic, Commercialization of algal strains for education purpose. Bioinformatics tools and databases.

Practicals

1. Isolation of genomic DNA from algae
2. Separation of algal pigments using TLC
3. Amplification of DNA barcoding gene for molecular systematics
4. Demonstration of CYANOBASE, and retrieving of gene sequences for multiple sequence alignment for candidate gene for making phylogenetic tree using (MEGA 5.0, CLUSTAL X etc)
5. Determination of lipid peroxidation and hydrogen peroxide content in stressed and non-stressed cyanobacterium
6. DNA isolation, primer designing and PCR amplification of 16S rDNA sequences from *Anabaena* sp PCC 7120
7. Isolation of algal oil using Soxhlet apparatus
8. Demonstration of synthesis of nanoparticles using algal extract and its validation using spectrophotometer

Suggested Readings:

1. Andersen RA (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
2. Cole KM and Sheath RG (1990). Biology of the Red Algae. Cambridge Univ. Press, Cambridge.
3. Fritsch FE (1945). The Structure and Reproduction of Algae. Vol. II. Cambridge Univ. Press. Cambridge, London.
4. Isabella A. Abbott, George J and Hollenberg (1993). Marine Algae of California. Stanford University Press. USA.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M3BOT04-ET02-D	APPLIED PLANT SCIENCES

Unit-I Credit hours: 12

Biofertilizers: General account about the microbes used as biofertilizer – *Rhizobium, Azospirillum, Azotobacter,* Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, Mycorrhizal association; colonization of VAM. Organic farming – Green manuring and organic fertilizers.

Unit-II Credit hours: 12

Nursery development: objectives and scope. Planning and seasonal activities - Planting - direct seeding and transplants. Vegetative propagation: air-layering, cutting, treatment of cutting, rooting medium and planting of cuttings. Hydroponics

Unit-III Credit hours: 12

Floriculture: Importance and scope of floriculture and landscape gardening. Ornamental Plants: Flowering annuals; Herbaceous perennials. Bonsai. Commercial Floriculture: Factors affecting flower production. Hardening of plants – green house - mist chamber, shed root, shade house and glass house.

Unit-IV Credit hours: 12

Plant disease management: Symptoms of plant diseases. Control methods. Integrated pest management. Study of etiology and management of following important plant diseases; Downy mildew and Green ear of bajra, Blight of maize, Tikka disease of groundnut, Leaf blight of rice, Grassy shoots of sugarcane, Sandal spike, Rice tungro, Bunchy top of banana. Diseases and Pests of Ornamental Plants.

Unit-V Credit hours: 12

Intellectual Property Rights: Introduction to Intellectual Property. Historical Perspective, Different Types of IP, Importance of protecting IP. Copyrights, Trade Marks, Patents, Geographical Indications, Trade Secrets, Different International agreements; Word Trade Organization (WTO), General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS).

Practicals:

1. Effect of mycorrhizal inoculation on plant growth.
2. Study of root nodule development
3. Effect of Blue Green algae on plant growth
4. Various nursery and gardening practices

5. IPR issues-case studies
6. Study of important plant diseases

Reference Books

1. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad
2. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
3. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
4. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
5. Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
6. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).
7. Nelson, P.U. 1991. Greenhouse operation and management. Prentice-Hall, NJ, USA.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Discipline Specific Electives

M4BOT04-ET04-D	COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES

Unit-I Credit hours: 12

Micropropagation technology: Global opportunities, growth of tissue culture industry in India. Scope of commercialization of tissue culture based technologies. Planning and design of tissue culture facility for mass propagation of plants. Concept of clean area. Mass media preparation and dispensation, and storage. Autoclaving and contamination control. Hatcheries, transfer area, control of physical environment in growth room, air – handling and conditioning, culture room lightning, air exchange, humidity control.

Unit-II Credit hours: 12

Commercialization: Economizing micropropagation through reduction in labor cost, space utilization, cost reduction in media constituents and innovative approaches e.g. CO_2 enrichment, automation in plant tissue culture-use of bioreactors and robotics. Culture vessel ventilation. *Ex Vitro* rooting. Natural light in culture rooms. Liquid culture and temporary immersion.

Unit-III Credit hours: 12

Green house technology: Greenhouse location design, glazing materials, greenhouse cooling and heating, evaporative cooling, axial flow fans and humidity control. Monitoring water quality-water softening, ion exchange, reverse osmosis and distillation. Control of insects pests and microbial infection. Fogging facility, misting systems, light control in greenhouse, General nursery practices, maintenance of plants under nursery shade.

Unit-IV Credit hours: 12

Applications: Available technologies for micropropagation of ornamentals, fruit plants plantation crops, spices and condiments, oil seeds and legumes. Costing of tissue culture raised plants, quality control, packaging, transport and shipment. Ex-agar and agar-gel transportation. Virus indexing, quarantine and health.

Unit-V Credit hours: 12

Entrepreneurship: Setting-up of a micropropagation based industry- SWOT analysis, capital and operational cost, market survey and product acceptance, technology

demonstration , preparation of project report, financial institutions and supports, marketing strategies, Export potential.

Practicals:

1. Basic concepts of laboratory planning: concept of clean area, Hatch windows, environmental control in growth rooms, transfer area, culture room lighting, air-exchange, humidity control.
2. Scale-up production of identified plant species involving – culture establishment, shoot multiplication, rooting and hardening and acclimatization.
3. Learning Innovations in micropropagation:
   (a) Liquid culture system
   (b) Support matrices
   (c) CO_2 enrichment
   (d) Temporary immersion
   (e) Culture vessal ventilation
4. Greenhouse design, operation and management:
   (a) Glazing materials
   (b) Forgging, Misting, Light Control
   (c) Greenhouse cooling
   (d) Greenhouse heating
5. Cost analysis exercises for tissue culture plants.
6. Project development, planning and execution – case studies

Reference Books:

1. Pierik, RLM (1987) *In vitro* culture of Higher Plants, Martinus Nijhoff Publishers, Dordrecht, The Netherlands.
2. Prakash, J. and Pierik, RLM (Eds.) 1992 "Plant Biotechnology: Commercial Prospects and Problems" Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Hartmann, HT, Kestar, DE, Davis, FT and Geneve RL 1997. Plant Propagation – Principles and Practices. Sixth Edition, Pretice Hall Inc. New Jersey, USA.
4. Jitendra Prakash 1995. Biotechnology Research and Industry Survey. Vadamalai Services, Pichanur, Coimbatore.
5. Vasil, IK (Ed.) 1991. Scale-up and Automation in Plant Propagatuion In "Cell Culture and Somatic Cell Genetics of Plant Vol. 8, Academic Press, N. York, USA.
6. Nelson, PV 1991. Greenhouse operation and Management (Fourth Edition), Prentice Hall Inc. New Jersey, USA.
7. Purohit, S.D. 2013. An Introduction to Plant Cell, Tissue and Organ culture. Prentice-Hall, India

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-01	ENGLISH COMMUNICATION

Unit-I **Credit hours: 6**

Introduction: Theory of Communication, Types and modes of Communication

Unit-II **Credit hours: 6**

Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication

Unit-III **Credit hours: 6**

Speaking Skills: Monologue Dialogue Group Discussion Effective Communication/ Mis-Communication Interview Public Speech

Unit-IV **Credit hours: 6**

Reading and Understanding Close Reading Comprehension Summary Paraphrasing Analysis and Interpretation Translation(from Indian language to English and vice-versa) Literary/Knowledge Texts

Unit-V **Credit hours: 6**

Writing Skills Documenting Report Writing Making notes Letter writing

Recommended Readings:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-02	COLLECTION, PROCESSING, PRESERVATION & SALE OF PLANT MATERIALS

Unit-I **Credit hours: 6**

Collection of specimens, storing in fixatives, type of fixatives, Stains and dyes; type of stains, natural dyes, coal tar dyes. Theory of staining, types of staining, differentiation, mordants, bleaching, staining, temporary preparation of free hand section, permanent preparation of free hand section, permanent preparation of microtome section.

Unit-II **Credit hours: 6**

Paraffin course; washing, dehydration, infiltration, embedding, sectioning, cutting wood cube, cutting paraffin block, cutting paraffin ribbons, mounting of ribbon, staining of sections.Whole mount preparation, bacteria, fungi, algae, bryophytes, pteridophytes, gymnosperms & angiosperms, study of stomata. Smear or squash procedure; anther, root tip.

Unit-III **Credit hours: 6**

Herbarium technique; collection process, equipments for collection, plant press, field book, blotting materials, pressing of plants, keeping wet materials, drying of specimens, mounting of specimens, labeling of specimen, storing of herbarium sheets, preservation of type specimen, important herbarium of the world and india.

Unit-IV **Credit hours: 6**

Culture technique; conditions, plugging, agar-agar, pouring of medium, marking of glassware, sterilization, autoclave, pouring of sterilized media, inoculation of hood and room, inoculation tools, transfer of culture, preparation of agar slant, maintenance of culture, fungi, algae, angiosperms

Unit-V **Credit hours: 6**

Solutions, true solution, suspension, concentration of solutions, acid, base and salt, dilute solution of acids, salts, measurement of pH, pH meter, glass electrode, buffer solution, phosphate buffer. Glasswares, graduated glassware, ungraduated glassware, cleaning of glassware. Strategy for sale of the classwork material and scope.

Suggested Readings

Dwivedi, J.N., Singh, R.B. 1985. Essential of Plant techniques. Scientific Publishers, Jodhpur.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-03	BIOFERTILIZERS

Unit I Credit hours: 6

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

Unit II Credit hours: 6

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 III Credit hours: 6

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

Unit IV Credit hours: 6

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 V Credit hours: 6

Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods,
types and method of vermicomposting – field Application.

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-04	BIOINFORMATICS

Unit-I Credit hours: 6

Introduction of computers: Components and their functions, hardware and software, Input-Output devices. Basic concepts about data and information, Representation of data in computers in binary, bits and bytes.

Unit-II Credit hours: 6

Programming languages: Computer words coding (ASCII and EBCDIC), Numeric data. Introduction to Programming languages, C^{++} Perl. Conceptual understanding of assemblers, Compilers, Operating System.

Unit-III Credit hours: 6

Biological Databases: Primary Sequence databases (Protein and DNA databases), Secondary databases, Composite databases.

Unit-IV Credit hours: 6

Sequence Alignment and Databases searching: Evolutionary basis of sequence alignment. Optimal Alignment methods, Substitution Scores and Gap penalties.

Unit-V Credit hours: 6

Sequence Alignment: Statistical significance of alignment, Databases similarity searching: FASTA, BLAST.
Pairwise database searching: EMBOSS, Multiple Sequence alignment: CLUSTAL W. BLIS Network in India.

Practicals:

Practicals will be based on theory course contents.
Primer Design
BLAST
Multiple Sequence Alignment

Reference Books:

1. Fundamental of Computer: P.K. Sinha

2. Introduction to Bioinformatics: Parrysmith and Attwood.
3. Introduction to Bioinformatics: Baxevenis and Oulette.
4. Internet for Molecular Biologist: Swindell.
5. Molecular databases for protein sequences and structure studies – An Introduction Silence: J., Sillince M., Springerberlagd, Berlin 1972.
6. Leaping from Basic to C^{++}: Robert J. Traister, A.P. Professional Cambridge.
7. Perl 5 Unleashed: Kamran Husain & Robert F. Breedlore SAMS Publishing.
8. Bioinformatics-Methods and Applications. Rastogi, Mendratta, Rastogi Prentice Hall, New Delhi.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-05	FOREST ECOLOGY

Unit-I Credit hours: 6

Ecology and Forest Ecology,Importance of Ecology in Forestry, WildlifeManagement, Agriculture pastureland management, Animal Husbandry, Human Health etc. Major roles of forest Ecology its relationship with Silviculture.

Unit-II Credit hours: 6

Limiting Factor, their role in forestry especially in afforestation activities, Silvicultural characteristics of important forest species. Ecological Indicators. Role of ecological Indicators in forestry. Safe site, Germination sites, seed traps.

Unit-III Credit hours: 6

Autecology and Synecology. Plasticity of the phenotypes. Ecotypes. Seed years, Seeding cycles,forest seed collection, forest seed storage, seed viability, Germination percentage, seed trade (scope and potential)

Unit-IV Credit hours: 6

Forest types of India, suitable species for afforestation in different forest types seed collection of important species,nursery techniques to raise seedlings of important forest species. Ornamental plant nursery , scope and opportunities, layering, gutty,Bonsai, pooktre, basket trees plant lattice,ornamental plant raising techniques, tree fusion, medicinal plant nursery, fruit plant raising techniques

Unit-V Credit hours: 6

Lawn development and management. Advertising and management, pasture land management, grass seed collection, grass nurseries, garden waste management, fencing methods, tree guards, topiary, tall plants; planting methods, roof top gardens, wall gardens, water economy methods in plantations, gardens, nurseries, pot plants lawns etc.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-06	INTELLECTUAL PROPERTY RIGHT

Unit I Credit hours: 6

Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP. Copyrights Introduction, How to obtain, Differences from Patents. Trade Marks Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Unit II Credit hours: 6

Patents Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India. Geographical Indications Definition, rules for registration, prevention of illegal exploitation, importance to India.

Unit III Credit hours: 6

Industrial Designs Definition, How to obtain, features, International design registration. Layout design of integrated circuits Circuit Boards, Integrated Chips, Importance for electronic industry. Trade Secrets Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Unit IV Credit hours: 6

Different International agreements (a) Word Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS) (iii) Madrid Protocol (iv) Berne Convention (v) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity

Unit V Credit hours: 6

IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Reference Books:

N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001)

Manjula Guru &*M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001).
Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
Jayashree Watal, *Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-07	NURSERY, GARDENINING & GREEN HOUSE PRACTICES

Unit-I Credit hours: 6

Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology - seed testing and certification.

Unit-II Credit hours: 6

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants – green house - mist chamber, shed root, shade house and glass house.

Unit-III Credit hours: 6

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.

Unit-IV Credit hours: 6

Cultivation of Vegetables: 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.

Unit –V Credit hours: 6

Green house: Fundamentals of greenhouse structures and greenhouse design, heating and cooling, benching, lighting, irrigation, and fertigation systems, and greenhouse maintenance. Greenhouse pest control. Different kinds of plants grown in a greenhouse such as foliage plants, bedding plants, flowering plants, vegetables and cut flowers. Soilless media; Vermiculite, Soilrite, Coeopeat. Water treatment plants.

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., Bangalore, Madras.
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, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National _Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.
7. Nelson, P.V. 1991. Greenhouse Operation and Management. Prentice Hall, New Jersey, USA.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-08	ENVIRONMENTAL MONITORING, MANAGEMENT AND RESTORATION

Unit-I Credit hours: 6

Environmental pollution: Types (Air, Water, Soil, Radioactive, Noise, Thermal), effects on plants, animals and buildings; control of pollution; indoor air pollution.
Green house effect and global warming; ozone depletion; UV- B radiations; acid rain.
Environmental monitoring; Biomonitoring; Bioindicators.

Unit-II Credit hours: 6

Biological diversity: Threats to biodiversity, major causes of extinction, vulnerability of species to extinction, IUCN threat categories, Red data book. Strategies for biodiversity conservation,

Unit -III Credit hours: 6

principles of biodiversity conservation *in-situ* and *ex-situ* conservation strategies, theory of reserve design; Biosphere reserves. Megadiversity zones and Hot spots, concepts, distribution and importance.Threatened plants of India.

Unit -IV Credit hours: 6

Waste management: Solid Waste; Sources and management; Composting and methane production; Hazardous waste; Disposal and management of radioactive waste. Industrial ecology and recycling industry.

Unit -V Credit hours: 6

Environmental Biotechnology – Scope and applications; Concept of cleaner technology.

Practicals:

1. Determination of phenol contents of the given plant samples growing in polluted and seemingly non-polluted environments.

2. Determination of chlorophyll ‘a’, ‘b’ and total chlorophyll contents of the given plant samples growing in polluted and seemingly non-polluted environments.
3. Determination of soluble protein contents of the given plant samples growing in polluted and seemingly non-polluted environments.
4. Determination of carbohydrate contents of the given plant samples growing in polluted and seemingly non-polluted environment.
5. Determination of the proline contents of plants growing in polluted and seemingly non-polluted environments.
6. Determination of the activity of acid phosphatase enzyme in the given plant samples growing in polluted and seemingly non-polluted environments.
7. Determination of the activity of peroxidase enzyme in the given plant samples growing in polluted and seemingly non-polluted environments.
8. Determination of the activity of polyphenol oxidase enzyme in the given plant samples growing in polluted and seemingly non-polluted environments.
9. Determination of the activity of nitrate reductase enzyme in the given plant samples growing in polluted and seemingly non-polluted environments.
10. Calculate the dust capturing capacity of the leaves provided to you.
11. Calculate the percentage of the injured area in the leaves provided to you.
12. Study the effect of different lead and cadmium concentrations on the germination of seeds
13. Determination of the Dissolved Oxygen content of the given water samples.
14. Determination of the hardness of the given water samples.
15. Determination of the alkalinity of the given water samples.
16. Determination of the acidity of the given water samples.
17. Determination of the residual chlorine in the given water samples.
18. Determination of the organic carbon contents in the given soil sample.
19. Determination of the contents of calcium carbonate in the given soil sample.
20. Measurement of alpha and beta counts in soil samples
21. Field survey of important plants of the region for biodiversity.
22. Study of IUCN Red list categories.

Reference Books:

1. Bradshaw, A.D. and Chadwick, M.J. 1980. The Restoration of Land. Blackwell Scientific Publications, Oxford.

2. Singh A and Ward O.P. (Eds.). Applied Bioremediation and Phytoremediation. Springer. 2004.
3. Abrol I.P. and Dhruva Narayan V.V. (Eds.). Technologies for Wasteland Development. ICAR, New Delhi. 1998.
4. K.V.S.G. Murlikrishan. Air pollution and control.
5. Bell & Bell. Industrial noise control.
6. Peary. Environmental engineering.
7. Gilbert Masters. Introduction to environmental engineering and science.
8. Owen and Chiras. Natural Resource Conservation.
9. K.D. Saxena. Environmental planning, policies and programs in India.
10. G.W.Cox. Conservation Ecology.
11. W.R. L. IUCN. Global Biodiversity. Aery N.C. 2010. Manual of Environmental Analysis. Ane Books. New Delhi.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Skill Course Elective

BOT-SP-09	SCIENTIFIC WRITING

Unit I **Credit hours: 6**

Choosing the right word, using a dictionary and thesaurus, basic elements of a sentence, clauses, true sentence, tenses, active and passive verbs, punctuation and parallelism, Paragraphs, logic, and organization. Organizational strategies, art of precise writing.

Unit II **Credit hours: 6**

Using web based search engines, authenticating the information, editing in MS office, style analysis programs, data entry and working knowledge of excel, creating tables, figures, graphs, photographs and other documentary illustrations, explanatory artwork, An introductory idea about use of abode, photoshop and coral making powerpoint presentation, making and refining presentations using advanced presentation features, making a poster, using a library, indexing systems available for various science streams, e-resources, e-journals, INFLIBNET and Sodhganga.

Unit III **Credit hours: 6**

Introduction-Overview of science writing, how is scientific writing different from general writing, know your audience, writing for general public, science reporting, Science news, explanatory writing, lengthy magazine article, popular articles and popular lectures. Reading material: Popular science magazine articles.

Unit IV **Credit hours: 6**

Writing for scientific community, types of paper (short communication, original research article, review), the various components for each type and the content of each components (title, author affiliation, abstract , key words, introduction, material and

methods, results and discussion, conclusion, references and bibliography, citation. Ethics in writing, plagiarism, plagiarism checker on line.

Unit V Credit hours: 6

Publishing work: selection of journal, impact factors, h index, following author guidelines, on line submission, proof reading of a manuscript, understanding the symbols, reviewing of a manuscript, making corrections and answering reviewers query, galey proof reading. Writing research grant proposal, Book review, write up mini profiles of prominent scientists, letters to editor, opinion writing, interview of a scientist, career in scientific writing

Practical/Assignments:

1. Take a science article and reduce it to 1/10 th length and make a brief abstract.
2. Make a press release for the general masses about a scientific event in your city.
3. Make a Review of an instrument, technique or Technology
4. Make a Powerpoint presentation on topic of your choice.
5. Make a poster on selected topic.
6. Convert the assignment 3 for general public
7. Collect few science news, science magazine article, popular articles on science and read them in class and critically discuss them.
8. Make a report of a practical exercise or a field visit.
9. Write a short communication on the given selected practical exercise in the given selected journal.
10. Peer review the article written by your class mates with proof reading symbols and on line review tool.
11. Frame questions for interview of a well known scientist/or on campus scientists
12. Make a small research grant proposal.
13. Write a mini profile of a prominent scientist.

Annexure I

1. In the 3rd and 4th semester students one in-house minor research project within the department or in sister departments of this University in lieu of one DSE. Such students will also have to submit a dissertation report as per the prescribed format for the training. (Annexure 1)
2. The total credits and marks for minor research project will be the same as for any other DSE and Evaluation of the minor research project will be done as per the prescribed scheme. (Annexure 2)
3. The total contact hrs. for minor research project will be 8 hrs./week. The student who opts for industrial training will have submit a duly signed and sealed certificate from the mentor and competent authority in the prescribed format (Annexure 3)
4. Students can choose skill courses from the list provided in the syllabi of M.Sc. Biotechnology, M. Sc. Botany, M. Sc. Microbiology or any other subject from the faculty of Science. The student also has the choice of choosing any general skill courses offered by College of Science
5. Students can also earn extra credits by taking addition skill courses during entire program period.

General Guidelines for Preparation of Project Report

(For specific details the students are advised to consult their respective supervisors)

1. Strictly follow the format given to write the manuscript of the project.
2. On the front page include title of the project (font size 21, centered). The title should not contain abbreviation and scientific names of organisms should be in *italics*. This page should not be numbered.
3. Starting from second page, the pages must be numbered consecutively, including figures and table.
4. Text should be 1.5 point spaced type written using Times New Roman Font, Font Size 12, on one side of A 4 Size paper, with 1.5 inch margins throughout. Scientific names of the organisms should be in *italics*. Main headings (Summary, Introduction, Chapter details, Conclusions and References) should be bold type, justified and separated from the text.
5. The full text of project should not exceed 20-25 one side typed pages.
6. Literature citation in the text should be cited in alphabetic order. The form and style of references should be as indicated below.

(a) Journal article

Carvalho, L.C., Goulao, L., Oliveira, C., Goncalves, C.J. and Amancio, S. 2004. Rapid assessment for identification of clonal identity and genetic stability of *in vitro* propagated chestnut hybrids. Plant Cell Tiss. Org. Cult. 77:23-27.

Chae, W.B., Choi, G.W. and Chung, I.S. 2004. Plant regeneration depending on explant type in *Chrysanthemum coronarium* L. J. Plant Biotech. 6:253-258.

(b) Book reference

Salisbury, F. B., Ross, C. W. 1992. Plant Physiology. 4th edn. Wadsworth Publishing Company. Belmount.

(c) Edited books

Constantine, D.R. 1986. Micropropagation in the commercial environment. In : "Plant Tissue Culture and its Agricultural Applications". L.A. Withers and P.G. Alderson (Eds.) pp. 175-186. Butterworths, London, UK.

(d) Paper presented at a conference

Chaturvedi, H.C. 1992. Hardening of *in vitro* raised plants for transplant success. A state of art report. Paper presented in DBT Project Monitoring Committee Meeting held on 6^{th}-7^{th} July, 1992 in DBT, New Delhi, India.

(e) Proceeding of a symposium

Rajsekharan, P. E., Ganeshan, S. 2005. Designing *exsitu* conservation strategies for threatened medicinal plant species of South India. In: " Proc. Natl. Symp. and 27^{th} Annual Meeting of PTCA(I)." A.K. Kukreja *et al* (Eds). Pp.159-164. CIMAP, Lucknow, India.

(f) Thesis/ Dissertation

Dave, N. 2004. Factors influencing micropropagation of two varieties of *Achras sapota* and their rootstock *Mimusops hexandra*. Ph.D. Thesis, Mohanlal Sukhadia University, Udaipur, India.

(g) Patent

Trepaginer, J.H. 2000. New surface finishings and coatings. US Pat 1276323 (to DuPont Inc, USA). 27 June, 2000. Chem Abstr, 49 (2000) 27689.

(h) Reports

Anonymous, 1976. The Wealth of India. Raw Meterials. Vo. X. pp. 44-48. CSIR, New Delhi, India.

TITLE MUST BE IN CAPITAL LETTERS, SIZE 21 AND CENTERED, WITH *Scientific names* IN ITALICS

A Project Report submitted

for the partial fulfillment of the Degree of Master of Science

By

(**Name of student**)

[M.Sc. (BOTANY), IV Semester]

DEPARTMENT OF BOTANY

MOHANLAL SUKHADIA UNIVERSITY

UDAIPUR

201__-1__

INSTITUTE NAME AND LOGO

Ref no.-…….. Date……

CERTIFICATE

This is to certify that the dissertation/project report entitled "**……**" submitted towards the partial fulfillment for the award of the degree of Master of Science in Biotechnology, from Mohanlal Sukhadia University, Udaipur (Rajasthan) India is the result of bonafide work compiled by **Mr./Ms. …….** carried outunder the guidance of **Dr. ……** at **……..** under my supervision in the academic year of …….. It has no part the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date

Name & Signature of the supervisor

Seal of the supervisor

Declaration

I, **……..** Roll No. **_____**student of M. Sc. IV Semester Biotechnology (Session 2010-11) hereby declare that the project entitled "……..." is my own compilation. I have strictly adhered to the guidelines provided by the department for the preparation of the project report.

Dated: Signature of the Student

TABLE OF CONTENTS

Annexure II

MARKING SCHEME FOR MINOR RESEARCH PROJECT

M. Sc. BOTANY semester IV

S. No.		Maximum Marks	Marks Obtained
1	**Dissertation Report** a. Review of Literature b. Methodology c. Outcome	 15 10 15	
2	Seminar	25	
3	Viva – voce	15	
4	Continuous Assessment	20	
	TOTAL MARKS	**100**	

Annexure III

CONTINUOUS ASSESSMENT SHEET

M. Sc. BOTANY: Minor Research Project

Name of Student's :

Technical Competence	Maximum Marks	Minimum Marks
• Review of Literature	5	
• Experimental Design & Skills	5	
• Data Interpretation/ Result Analysis	5	
• Attendance	5	
GRAND TOTAL	**20**	

Remark on professional competence (or deficiency) of the trainee and overall performance.

Name :

Designation : E-mail…….

Ph. No.

Organization:

Date: Signature with seal

Annexure IV

Internal Assessment of Practical

Practical Examination Question Paper Pattern (Internal)

DEPARTMENT OF BOTANY

UNIVERSITY COLLEGE OF SCIENCE, M.L. SUKHADIA UNIVERSITY

UDAIPUR

M.SC. (SEMESTER -) BOTANY – 20 -

PRACTICAL – I/II

PAPER: _____

PAPER: _____

(BASED ON THEORY PAPER – &)

TIME : 2 HOURS **MAX. MARKS: 20**

1.	Major Question (from Paper one mentioned above)	**5**
2.	Major Question (from Paper two mentioned above)	**5**
3.	Identify and comment upon the Spots (1-4) (Two from each paper)	**4**
4.	Record	**3**
5.	Viva – Voce.	**3**
	Total	**20**

External Assessment of Practicals

Practical Examination Question Paper Pattern (End Semester)

DEPARTMENT OF BOTANY

UNIVERSITY COLLEGE OF SCIENCE, M.L. SUKHADIA UNIVERSITY

UDAIPUR

M.SC. (SEMESTER -) BOTANY – 20 -

PRACTICAL – I/II

PAPER: _____

PAPER: _____

(BASED ON THEORY PAPER – &)

TIME : 6 HOURS **MAX. MARKS: 80**

1.	Major Question (from Paper one mentioned above)	**16**
2.	Minor Question (from Paper one mentioned above)	**08**
3.	Major Question (from Paper two mentioned above)	**16**
4.	Minor Question (from Paper two mentioned above)	**08**
5.	Identify and comment upon the Spots (1-6) (Two from each paper)	**12**
6.	Record	**10**
7.	Viva – Voce.	**10**
	Total	**80**

Internal Assessment of Theory Papers

DEPARTMENT OF BOTANY

UNIVERSITY COLLEGE OF SCIENCE, M.L. SUKHADIA UNIVERSITY

UDAIPUR

M.SC. (SEMESTER -) BOTANY – 20 -

1. Assignment: 5 marks
2. Seminar: 5 marks
3. Internal test: 10 marks

Internal test question paper pattern: 10 marks

Part A: Five questions compulsory, each of one mark

Part B: Attempt two questions, with internal choice, each of 2.5 marks.