Mohanlal Sukhadia University
Udaipur

Department of Botany

Syllabus and Scheme of Examination

For

M.Sc. CBCS Programme Botany

Department of Botany

Mohanlal Sukhadia University

CBCS Scheme of Syllabus for M.Sc. Botany

Course code	Title of the Course	No. of credits	University exam	Internal assessment	Total
SEMESTER I					
M1BOT01-CT01	Biology and Diversity of Plants (Microbes, Algae and Fungi)	4	80	20	100
M1BOT02-CT02	Biology and Diversity of Archegoniate	4	80	20	100
M1BOT03-CT03	Cell Biology and Biochemistry	4	80	20	100
M1BOT04-CT04	Plant Ecology and Biodiversity Conservation	4	80	20	100
M1BOT05-CP01	Practical	4	80	20	100
M1BOT06-CP02	Practical	4	80	20	100
			480	120	600
SEMESTER II					
M2BOT01-CT05	Genetics and Evolution	4	80	20	100
M2BOT02-CT06	Molecular Biology	4	80	20	100
M2BOT03-CT07	Structural and Reproductive Plant Biology	4	80	20	100
M2BOT04-CT08	Plant Growth and Development	4	80	20	100
M2BOT05-CP03	Practical	4	80	20	100
M2BOT06-CP04	Practical	4	80	20	100
BOT-SP	Skill course elective 1 (any one)	2	80	20	100
			560	140	700
SEMESTER III					
M3BOT01-CT09	Plant Physiology	4	80	20	100
M3BOT02-CT10	Plant Systematics & Resources Utilization	4	80	20	100
M3BOT01-ET01 (A/B/C/D)	DSE 1	4	80	20	100
M3BOT02-ET02 (A/B/C/D)	DSE 2	4	80	20	100
M3BOT05-CP05	Practical	4	80	20	100

M3BOT06-EP01	Practical	4	80	20	100
			480	120	600
SEMESTER IV					
M4BOT01-CT11	Genetic Engineering of Plants	4	80	20	100
M4BOT02-CT12	Analytical Techniques in Plant Sciences	4	80	20	100
M4BOT03-ET03 (A/B/C/D)	DSE 3	4	80	20	100
M4BOT04-ET04	Minor Research Project	4	80	20	100
M4BOT05-CP06	Practical	4	80	20	100
M4BOT06-EP02	Practical	4	80	20	100
BOT-SP	Skill course elective 2 (any one)	2	80	20	100
			560	140	700

Core Courses

Course Code	Title of the Course
M1BOT01-CT01	Biology and Diversity of Plants (Microbes, Algae and Fungi)
M1BOT02-CT02	Biology and Diversity of Archegoniate
M1BOT03-CT03	Cell Biology and Biochemistry
M1BOT04-CT04	Plant Ecology and Biodiversity Conservation
M2BOT01-CT05	Genetics and Evolution
M2BOT02-CT06	Molecular Biology
M2BOT03-CT07	Structural and Reproductive Plant Biology
M2BOT04-CT08	Plant Growth and development
M3BOT01-CT09	Plant Physiology
M3BOT02-CT10	Plant Systematics & Resources Utilization
M4BOT01-CT11	Genetic Engineering of Plants
M4BOT02-CT12	Analytical Techniques in Plant Sciences
M1BOT05-CP01	Practical 1
M1BOT06-CP02	Practical 2
M2BOT05-CP03	Practical 3
M2BOT06-CP04	Practical 4
M3BOT05-CP05	Practical 5
M4BOT05-CP06	Practical 6

Discipline Specific Electives

DSE1

Course Code	Title of the course
M3BOT01-ET01A	Applied Plant Sciences
M3BOT01-ET01B	Bioinformatics
M3BOT01-ET01C	Secondary Metabolites Production
M3BOT01-ET01D	Biosystematics

DSE2

Course Code	Title of the course
M3BOT02-ET02A	Plant Tissue Culture
M3BOT02-ET02B	Biology and Evolution in Bryophytes
M3BOT02-ET02C	Agrostology
M3BOT02-ET02D	Industrial Biotechnology and Bioprocess engineering

DSE3

Course Code	Title of the course
M4BOT03-ET03A	Advanced Plant Pathology
M4BOT03-ET03B	Stress Physiology
M4BOT03-ET03C	Environmental Monitoring, Management and Restoration
M4BOT03-ET03D	Commercialization of Micropropagation Technologies

Practicals

Course Code	Title of the course
M3BOT06-EP01	Practical 1
M4BOT06-EP02	Practical 2

Skill Enhancement Course Elective

Course Code	Title of the course
BOT-SP01A	Biofertilizers
BOT-SP02A	Collection, Processing, Preservation & Sale of Plant materials
BOT-SP03A	Intellectual Property Right
BOT-SP04A	Nursery, Gardenining & Green House Practices
BOT-SP05A	Bioinformatics
BOT-SP06A	Environmental Monitoring, Management and Restoration
BOT-SP07A	Commercialization of Micropropagation Technologies

NOTE:

1. In the 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.

ANNEXURE 1

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 2

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 3

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

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –I (2016-17)

Core course 1: ***M1BOT01-CT01***

Paper-I: ***Biology and Diversity of Plants (Microbes, Algae and Fungi)***

Unit-I Credit hours: 12

Archaebacteria and Eubacteria: General characters, distribution, ultra-structure, nutrition, multiplication, biology, economic and evolutionary importance. Methods of genetic recombination and their significance. Isolation, culture and identification of bacteria.

Unit-II Credit hours: 12

Viruses: Physical and chemical characteristics, ultra-structure, multiplication, isolation and purification and economic importance. Plant virus transmission.
Mycoplasma, phytoplasma, L-forms, viroids, rickettsias, sprioplasma and prions: A general account, economic and evolutionary importance.

Unit –III Credit hours: 12

Algae: General account, thallus organisation, cell structure, reproduction, life cycle pattern, classification schemes. Salient features of Cyanophyta, Chlorophyta , Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

Unit-IV Credit hours: 12

Algae: Salient features of Prochlorophyceae, Glaucophyceae, Eustigmatophyceae. Economic and evolutionary importance of algae.
Fungi: General characters, life cycle patterns, ultra-structure, mycelial growth, cell composition, nutrition (necrotrophs, biotrophs and symbionts), methods of reproduction. Recent trends in classification and phylogenetic relationship among fungal groups.

Unit-V Credit hours: 12

Fungi: General account of morphology, reproduction, life cycle and economic importance of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Fungi *imperfecti*. Economic importance of fungi. Heterothallism, Heterokaryosis and Parasexuality in fungi.
Fungal associations: Mycorrhizae and Lichens; General account of morphology, reproduction, life cycle and significance.

Practicals:

1. Isolation culture and identification of bacteria from various sources.
2. Identification of cultured bacteria using Gram's stain.
3. Identification of cyanobacteria and study of heterocyst.
4. Microscopic preparations and study of following algal materials: *Nostoc, Oscillatoria, Anabaena, Microcystis, Spirulina, Chlamydomonas, Volvox, Coleochaete, Hydrodictyon, Ulva, Cladophora, Pithophora, Oedogonium, Vaucheria, Chara, Ectocarpus, Sargassum, Batrachospermum, Polysiphonia*, Diatoms- Available genera.
5. Isolation and establishment of axenic algal culture
6. Study and identification of following fungal genera: *Synchytrium*, *Phytopthora*, *Peronospora*, *Mucor*, *Penicillium*, *Erysiphe*, *Claviceps*, *Agaricus*, *Puccinia*, *Uromyces*, *Melampsora*, *Sphacelotheca*.
7. Isolation and identification of mycorrhizae associated with various plant species.
8. Study of lichens
9. Local field trip

Reference Books:

1. Bold H. C and Wynne M.J (1975). Introduction to the Algae: Structure and Reproduction Prentice Hall Biological Science Series.
2. Chapman V.J and Chapman D.J (1973). The Algae. Macmillan and company, New York.
3. Fritsch F.E (1945). The Structure and Reproduction of the Algae Volume I and II, Cambridge University Press.
4. Kumar H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
5. Morries I. 1986. An Introduction to the Algae. Cambridge University Press, U.K.
6. Round F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.
7. Vijayraghavan M.R and Bela Bhatia (1997), Brown Algae: Structure, Ultrastructure and Reproduction, APH publishing Corporations, New Delhi.

8. Vijayraghavan M.R and Bela Bhatia (1997), Red Algae: Structure,Ultrastructure and Reproduction, APH publishing Corporations, New Delhi.

9. Alexopoulus, C. J., Mims, C. W. and Blackwel, M., Introductory Mycology, John Wiley & Sons Inc. Mandahar, C. L. Introduction to Plant Viruses. Chand & Co. Ltd., Delhi. Mehrotra, R. S. and Aneja, R. S. An Introduction to Mycology. New Age Intermediate Press.

10. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007

11. Textbook of Microbiology; Kanika Sharma. Ane books. New Delhi. 2011

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –I (2016-17)

Core course 2: M1BOT02-CT02

Paper II: *Biology and Diversity of Archegoniate*

Unit –I Credit hours: 12

Bryophytes: Origin of Bryophytes. General characters and classification. Evolution of gametophyte and sporophyte. Comparative study of structure, reproduction and life cycle of Hepaticopsida.

Unit –II Credit hours: 12

Bryophytes: Comparative study of structure, reproduction and life cycle of Anthocerotopsida and Bryopsida. Economic and Ecological importance of Bryophytes.

Pteridophyta: Evolution of stelar system; Evolution of Prothallus; soral evolution; Heterospory and seed habit; Cytological evolution of ferns; Apogamy and Apospory. Telome theory.

Unit –III Credit hours: 12

Pteridophyta: General account of present and past distribution with special reference to India. Study of structure, reproduction, evolution, classification and inter-relationships of the Pteridophyta with special reference to Rhyniophytopsida, Psilotopsida, Lycopsida, Sphenopsida, Pteropsida.

Unit –IV Credit hours: 12

Palaeobotany: Geological time scale, types and nomenclature of fossils, fossilization, methods of study of fossils. Study of fossil archegoniates.

Gymnosperms: General account of present and past distribution of gymnosperms with special reference to India. Economic importance of gymnosperms, phylogeny and relationships of the main groups of gymnosperms.

Unit –V Credit hours: 12

Gymnosperms: Study of structure, reproduction, evolution, classification, life history with special reference to Cycadopsida, Coniferopsida, Gnetopsida. Evolution of the female strobilus in Coniferales.

Practicals:

- Study of external and internal morphology and microscopic preparations of following Bryophytes: *Riccia, Marchantia, Plagiochasma, Astrella, Targionia, Pellia, Porella, Anthoceros, Notothylus, Sphagnum, Pogonatum, Funaria, Rhodobryum* and *Polytrichum*.
- Study of temporary, double stained microscopic preparations of Root/ stem/ rhizome/ petiole/ reproductive parts of following pteridophytes:
- *Psilotum, Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Osmunda, Lygodium, Gleichenia, Cyathea, Dryopteris, Pteris, Actiniopteris, Adiantum, Marsilea, Salvinia and Azolla*.
- Permanent double stained microscopic preparations of T.S., T.L.S. and R.L.S. of stem of *Ginkgo, Pinus, Biota, Araucaria, Taxus, Taxodium, Agathis, Picea, Cephalotaxus, Cedrus, Podocarpus, Abies, Cupressus, Juniperus, Gnetum, Ephedra*
- T.S. Leaflet and Rachis of *Cycas* and *Zamia* and needle of *Pinus.*
- T.S. of coralloid root of *Cycas*.
- Microscopic preparations of male cone of *Pinus* and male and female cones of *Ephedra*.
- Study of male cone and megasporophyll of *Cycas.*
- Study of fossil slides and specimens.
- Local field trip

Reference books

1. Chandrakant, Pathak (2003). Bryophyta, Dominant Publishers and Distributors, New Delhi.
2. Parihar N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
3. Puri P. 1980. Bryophytes. Atma Ram and Sons, Delhi.
4. Rashid A (1998). An introduction to Bryophyta. Vikas Publishing House Pvt. Ltd, New Delhi.
5. Bhatnagar S.P and Moitra Alok 1996. Gymnosperms. New Age International Pvt. Ltd.Publishers, New Delhi, 470 pp.
6. Bierhorst D.W. 1971. Morphology of Vascular Plants. New York and London.
7. Biswas C and Johari B.M 2004. The Gymnosperms Narosa Publishing House, New Delhi.497 pp.
8. Parihar N.S. 1996. Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
9. Stewart W.N. and Rathwell G.W. 1993. Paleobotany and the Evolution of Plants. Cambridge University Press. Cambridge.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –I (2016-17)

Core course 3: M1BOT03-CT03

Paper III: *Cell Biology and Biochemistry*

Unit-I Credit hours: 12

Cell: Types, Intracellular compartments; Signal hypothesis, protein sorting to mitochondria and chloroplasts. Structure and functions of; cellular membranes, cell wall and cell organelles (nucleus, mitochondria, chloroplasts, Golgi apparatus, lysosomes, endoplasmic reticulum, vacuoles, ribosomes, and cytoskeleton). Synthetic cell and recent developments. Cell division: mitosis and meiosis.

Unit-II Credit hours: 12

Chromosomes: Structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, Nucleosome structure, DNA scaffolds and loops. Types, occurrence, organization and biological significance of Lampbrush and Polytene chromosomes, Supernumerary chromosomes, Structural and numerical alterations in chromosomes: duplication, deficiency, inversion, translocation heterozygotes, Haploids, aneuploids and euploids; C-value and C-value paradox, Cot curve and its significance.

Unit-III Credit hours: 12

Bioenergetics: Principles of the thermodynamics, free energy and chemical potential, free energy of Oxidation – reduction reactions, redox potential. Types of Phosphorylations, structure and functions of Energy carriers (ATP, GTP, NADP, FADH etc.)

Fats and Lipids: Volatile oils, Fatty acids and fatty oils, Sesquiterpenes, diterpenes, triterpenes and tetraterpenes. Structure and function of lipids, classification of lipids, fatty acids and their biosynthesis.

Unit-IV Credit hours: 12

Carbohydrates: Classification, structure, properties. Biosynthesis of starch and sucrose.

Enzymes: General characters, nomenclature and classification, Mode of enzyme action, Michaelis – Menton equation and its significance, Determining K_M and *Vmax*, Lineweaver-Burk (Double Reciprocal Plot). Regulation of enzymes, allosteric modulation, enzyme inhibition, coenzymes, isoenzymes. Factors effecting enzyme activity.

Unit-V Credit hours: 12

Amino acids: Structure, Types, Properties, Stereo-isomers, Functions, Biosynthesis and catabolism, Regulation of amino acid synthesis.

Proteins: Types, Properties, Structure, function, Cellular localization, Reverse turn and Ramchandran Plot.

Practicals:

1. General study of chromosomes: Mitosis: Onion, Meiosis: Onion.
2. Meiotic irregularity in *Rhoeo discolor*.
3. Study of Salivary gland chromosome in *Chironomas*.
4. Ultrastructure of cells, cell organelles (study through microphotographs)
5. Estimation of total fats in fatty seeds.
6. Preparation of standard curve of proteins (BSA)
7. Estimation of protein content in extracts of plant material by Bradford's method.
6. Determination of catalase activity
8. Demonstration of polyphenoloxidase activity.
9. Determination of saponification value of fats and oils

Reference Books:

1. G. Karp, 2015. Cell and Molecular Biology, John Wiley & Sans, Inc.
2. EDP De Robertis, 1987. Cell and Molecular Biology, Zea and Febiger.
3. H. Lodish, A. Berk, P. Matsudaira, C.A. Kaiser etc., 2009. Molecular Cell Biology, Scientific American Books.
4. Biochemistry; Voet and Voet, John Wiley & Sons, Inc., New York, USA.1992.
5. Biochemistry & Molecular Biology of Plants; Eds: Bob Buchanan, Wilhelm Gruissem, Russell Jones (Editor) Wiley; 1st. edition. 2002.
6. Biochemistry. Lubert Stryer, Jeremy M. Berg, John L. Tymoczko. W. H.Freeman and Co. 5th edition. 2002
7. Biochemistry; The molecular basis of cell structure and function. A. L. Lehninger. Worth Publishers. 1982.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –I (2016-17)

Core course 4: M1BOT04-CT04

Paper IV: *Plant Ecology and Biodiversity Conservation*

Unit-I Credit hours: 12

Environment: Physical environment, biotic environment.
Ecosystem concept: Structure and function, Ecological energetics; energy flow through ecosystem. Biogeochemical cycles (C, N, P and S cycles), Homeostasis. Principles of limiting factor.

Unit-II Credit hours: 12

Community ecology: Communities structure and dynamics, Edges and ecotones, processes shaping communities. Organismal and individualistic model of community. Succession: Concept, models and mechanisms. Life form and biological spectrum. Concept of niche; species coexistence.

Unit-III Credit hours: 12

Population ecology: Properties of populations, fluctuation, age classes; growth measurement; factors affecting population growth; r- and k- strategies; Life history patterns, Intraspecific population regulation, interspecific competition, type of interactions. Population Genetics and speciation. Adaptive radiation.

Unit-IV Credit hours: 12

Environmental pollution; agricultural pollution, atmospheric pollution, global environmental changes, mining and quarrying, restoration ecology. Environmental impact assessment. Environmental regulations and laws. Plant indicators. Phytoremediation. Sustainability**;** global carrying capacity. Basic concept of Industrial ecosystem. Environmental Biotechnology; Concept of clean technology & fundamentals of environmental biotechnology.

Unit-V Credit hours: 12

Phytogeography: Major biomes of the world with special reference to desert and grassland; phytogeographical regions of India.

Plant Biodiversity: Concept, levels of biodiversity, diversity indices, status in India, utilization and concerns. Hotspots. Conservation genetics and its application. Strategies for conservation – *In situ* and *Ex situ* conservation. International efforts and peoples participation for conservation

Practicals:

1. Determination of minimum size of quadrat (area species curve) of the grassland ecosystem.
2. Determination of minimum number of quadrats required for grasslands.
3. Determination of frequency, density, abundance and cover
4. Determination of Important Value Index (IVI)
5. Measurement of biodiversity using diversity indices.
6. Determination of leaf area index
7. Analysis of soil texture, moisture content, pH and water holding capacity
8. Determination of per cent organic carbon in the soils samples
9. Water analysis for Hardness, visibility of light in water column, carbonate, bicarbonate and chloride.
10. Estimation of dissolved oxygen content in eutrophic and oligotrophic water samples by Winkler's method.
11. Local field trip

Reference books:

Aery, N.C. 2010. Manual of Environmental Analysis, Ane Books Pvt. Ltd., New Delhi.

Ambasht, R.S. and Ambasht, N.K. 1999. A text book of Ecology. CBS Publ. & Distr. New Delhi.

Begon, M. Harper, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science, Cambridge, USA.

Brady, N.C. 1990. The nature and properties of Soil, MacMillan Press.

Campman, J.L. and Reiss, M.J. 1988. Ecology. Principles and Applications, Cambridge University Press, U.K.

Heywood, V.M. and Watson, R.T. 1985. Global Biodiversity Assessment, Cambridge Univ. Press, Cambridge.

Kormondy, E.J. 1996. Concepts of Ecology. PrenticeHall India Pvt.Ltd., New Delhi.

Ludwing, J. and Reynolds, J.F. 1998. Statistical Ecology. John Wiley & Sons.

Misra, R. 1968. Ecology Work Book. Oxford and IBH, New Delhi.

Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia.

Smith, R.L. and Smith T.M. 1998. Elements of Ecolgy. Benjamin/Cummings Publication.

Townsend, C.R., Begon, M., Harper, J.L. 2007. Essentials of Ecology. Blackwell Publishing.

Frankel, O.H., Brown, A.H.D. and Burdon, J.J. 1995. The Conservation of Plant Diversity, Cambridge University Press, Cambridge, U.K.

Heywood, V. (ed) 1995. Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press, Cambridge, U.K.

Katewa, S.S. & Jain Anita. Ethnobotany, Phytogeography, Plant Resources Utilization and conservation. Apex Publishing House, Jaipur. 2007.

Nair, M.N.B. et al. (eds) 1998. Sustainable Management of Non-wood Forest Products. Faculty of Forestry, University Putra Malaysia, 434004 PM Sardong, Selanger, Malaysia.

Swaminathan, M.N. & Jain, R.S. Biodiversity: Implications for global security, Macmillan, India. 1982.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –II (2016-17)

Core course 5 : *M2BOT01-CT05*

Paper I: *Genetics and Evolution*

Unit-I Credit hours: 12

Mendelism: Concept of gene, Mendel and his laws. Applications of laws and probability tests, Chi-square test and its application in the analysis of genetic data. Pattern of inheritance in haploid and diploid organisms.

Extension of Mendelism: alleles, allelic variation and genetic factor dominant relationship, basis of dominant and recessive inheritance, Multiple alleles and allelic series, pseudoallele, complementation tests, lethal alleles, penetrance and expressivity. Inheritance of genes, Pleiotropy.

,

Unit-II Credit hours: 12

Chromosomal basis of inheritance: Sex determination; Sex linked, sex influenced and sex limited traits; genetic marker, Linkage and crossing over, Linkage analysis and linkage map.

Extra chromosomal inheritance: Maternal inheritance, Extra-nuclear inheritance in Neurospora, Chlamydomonas, Paramecium, Yeast, Drosophila and Man, Mitochondrial genomes, Chloroplast genomes, Cytoplasmic male sterility.

Unit-III Credit hours: 12

Somatic cell genetics: Cell-cell hybridization, cell hybrids, mapping of genes by cell hybridization methods, Mapping by in-situ hybridization.

Genetic recombination: Recombination and genetic mapping, Homologous and non-homologous recombination, site-specific recombination. Molecular markers and mapping. Physical mapping of genes, artificial chromosomes,

Unit-IV Credit hours: 12

Pedigree: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Mutations: Spontaneous and induced mutations, physical and chemical mutagens. molecular basis of gene mutations, transposable elements in eukaryotes and prokaryotes.

Unit-V Credit hours: 12

Plant breeding; Introduction and objectives. Methods of crop improvement, advantages and limitations; Hybridization, mass selection, pure line selection; inbreeding depression, heterosis. Green revolution.

Evolution: Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; spontaneity of mutations; the evolutionary synthesis. Origin of cells and unicellular evolution: Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller; the first cell: origin and evolution in prokaryotes and eukaryotes.

Practicals:

1. Emasculation, crossing and bagging in crop plants.
2. Problem of genetics.
3. Karyotype determination in onion.
4. Barr body analysis.
5. Genetic exercises and test of goodness of fit using Chi-square

Reference books:

1. Khush G. S. Cytogenetics of aneuploides. Academic Press New York USA.
2. Burnham C. R. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
3. Hartl D. L. and Jones E. W. Genetics: Principles and Analysis Jones and Barew Publishers Massachusetts USA.
4. Karp G. 2015. Cell and Molecular Biology : Concepts and Experiments, John Wiley and Sons Inc USA.
5. Fikui K. and Nakayama S. Plant chromosomes; Laboratory Methods CRC Press Boca Ration Florida.
6. Gupta P. K. Cytogenetics. Rastogi Publication Meerut.
7. Prasad G. Introduction to Cytogenetics. Kalyani Publishers, New Delhi.
8. Sinha U. and Sinha S. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing house Pvt. Ltd. New Delhi
9. Sumner A.T. Chromosome and organization. Blackwell publishing
11. Swanson C. P., Merz T. and Young J. Cytogenetics. Prentice Hill of India Private Ltd. New Delhi.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –II (2016-17)

Core course 6: ***M2BOT02-CT06***

Paper II: ***Molecular Biology***

Unit-I Credit hours: 12

Cell cycle and DNA: interphase nucleus, role of cyclins and cyclin-dependent kinases. DNA structure and types (A-, B-, Z-, DNA). DNA replication, enzymes of DNA replication, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms.

Unit-II Credit hours: 12

RNA Structure, types, synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, elongation and termination, RNA processing: RNA editing, capping, polyadenylation, splicing, structure and function of different types of RNA, RNA transport. Reverse transcriptase.

Unit-III Credit hours: 12

Protein synthesis and processing: Genetic code, Ribosome, Translation: aminoacylation of tRNA, aminoacyl tRNA synthetase, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, translational proof-reading, translational inhibitors, post-translational modification of proteins. Isolation and purification of protein and nucleic acids, nucleic acid hybridization.

Unit-IV Credit hours: 12

Gene regulation: Regulation of gene expression in pro- and eukaryotes, the control sequences (operator, promoter, terminator, attenuator, enhancer, cis- and trans-acting elements), Operon model-Inducible and repressible systems, lac, gal, trp, his and arabinose operon, Attenuation, positive and negative regulation,, tissue specific gene expression. Role of chromatin in regulating gene expression and gene silencing. Cell fractionation,

Unit-V Credit hours: 12

Genomics and Proteomics: Introduction to Structural, functional genomics and its application to health and agriculture, including gene therapy. Brief account of Proteomics. Ribozymes.

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, metastasis, apoptosis, therapeutic interventions of uncontrolled cell growth.

Practicals:

1. Study of light and fluorescence microscope.
2. FISH technique for chromosome painting.
3. Isolation of genomic DNA and its visualization on Agarose gel.
4. Isolation of plasmid DNA and its visualization on Agarose gel.
5. Quantification of DNA.
6. Cot-curve preparation for given DNA sample.

Reference Books:

1. J.D. Watson, T.A. Baker, S.P. Bell etc., Molecular Biology of the Gene, Pearson Education, India.
2. J.W. Dale and Mv Schantz, From Genes to Genomes, John Wiley & Sons.
3. B.D. Singh, Biotechnology, Kalyani Publishers.
4. An Introduction to Molecular Biotechnology by M. Wink, Wiley-VCH.
5. Introduction to Molecular Biology, Genomics & Proteomics for Biomedical Engineers by M.R. Neuman, CRC Press.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –II (2016-17)

Core course 7*: M2BOT03-CT07*

Paper III: *Structural and Reproductive Plant Biology*

Unit-I Credit hours: 12

Meristems: Introduction, organization of meristems, shoot development– organization of the shoot apical meristems (SAM), wood development in relation to environmental factors. Organization of root apical meristem (RAM), lateral roots; root hairs. Floral meristems and floral development in *Arabidopsis*.
Tissue and tissue systems; Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem, Secretory structures and periderm

Unit –II Credit hours: 12

Plant anatomy: Primary and secondary structure of root and stem of angiosperms. Anomalous secondary growth in stem and roots of angiosperms with special reference to *Aristolochia, Salvadora, Bignonia, Achyranthes, Amaranthus, Boerhaavia, Mirabilis, Chenopodium, Dracaena, Tinospora*. Leaf anatomy. Leaf development and phyllotaxy.

Unit –III Credit hours: 12

Flower: Evolution of flower, genetics of floral organ differentiation; foliar stamens; open carpels; primitive living angiosperms; floral anatomy.
Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen germination, pollen tube growth and guidance, pollen embryos.

Unit –IV Credit hours: 12

Female gametophyte: Ovule development and types, placentation types and its evolution. Megasporogenesis, organization of the embryo sac, types of embryo sacs.
Pollination and Fertilization: pollen-pistil interaction; pollination mechanisms and vectors; sporophytic and gametophytic self-incompatibility. Double fertilization, *in vitro* fertilization.

Unit –V Credit hours: 12

Endosperm: Types, ultrastructure, endosperm haustoria, their extension, persistence and function.

Embryo-Polarisation of Zygote, embryogenic types, organogenesis of mono and dicot embryos. Structure and function of suspensor. Polyembryony – Types; genetic, somatic and pollen embryo. Apomixis. Seed development and fruit growth.

Practicals:

1. Training in paraffin wax method for preparation of serial sections from fixation to mounting of permanent slides
2. Staining of slides using single and double stains
3. Demonstration of slides showing embryological peculiarities (male and female gametophytes, endosperm, embryo)
4. Anatomical study of the following materials:

   Stem: *Boerhaavia, Achyranthes, Bignonia, Chenopodium, Leptadaenia, Nyctanthes, Salvadora, Dracaena, Triticum, Mirabilis, Aristolochia, Amaranthus, Chenopodium.*

   Root: *Tinospora, Ficus.*

   Floral anatomy: Buds of *Opuntia, Rosa, Calotropis, Hibiscus* and *Nerium*.
   Nodal Anatomy: *Calotropis, Nerium*

Reference books:

Bhojwani, S.S. and Bhatnagar, S.P. Embryology of Angiosperms (4th Revised and enlarged edition), 2000.

Burgess, J. 1985. An Introduction to Plant Cell Development, Cambridge University Press, Oxford.

Fahn, A. 1982. Plant Anatomy (3 rd Ed.), Pergamon Press, Oxford.

Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. Comparative Embryology of Angiosperms, Vol. I & II, SpringerVerlag.

Lyndon, R.F. 1990. Plant Development – The Cellular basis, Unnin Hyman, London.

Maheshwari, P. An Introduction to Embryology of Angiosperms, 1950.

Raghavan, V. 1999. Developmental Biology of Flowering Plants, SpringerVerlag, NewYork.

Shivanna, K.R. and Johri, B.M. The Angiosperm Pollen structure and Function, Wiley Eastern Ltd., Publications, 1989.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –II (2016-17

Core course 8: *M2BOT04-CT08*

Paper IV: *Plant Growth and Development*

Unit-I Credit hours: 12

Water relations: Chemical and Water potential. Absorption of water. Ascent of Sap, Transpiration, Factors affecting the rate of transpiration, Physiology of stomatal movement and regulation of transpiration. Guttation. Membrane transport: transport proteins, passive and active mechanisms.

Unit-II Credit hours: 12

Plant nutrition: Nutrient requirement of plants. Essential nutrients: macro and micronutrients, Chelating agents, Nutrient deficiency (Symptoms and disorders).
Seed: Seed development, germination and dormancy, bud dormancy, Ageing, Senescence and death.

Unit –III Credit hours: 12

Plant growth and Regulation: Over view, Historical account, Measurement of growth and growth kinetics. Plant growth regulators: Biosynthesis, chemical nature, physiological effects and mode of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, jasmonic acid and salicylic acid.

Unit –IV Credit hours: 12

Photomorphogenesis: Over view, Historical account, Photoreceptors: structure, function, properties (Phytochrome and cryptochrome), molecular mechanism of action and role in photomorphogenesis. Photoperiodism: significance, Florigen, floral induction and development, Vernalization.

Unit –V Credit hours: 12

Signal transduction: Basic concept and principles, Receptors and Second messengers (types, function), Signal transduction and gene expression, Signaling involving calcium, inositol phospholipids and G proteins, Two component sensor regulator system. Plant movements and taxis; Types, role of signal transduction.

Practicals:

1. Study of effect of radiation on seed germination.
2. Determination of gibberellic acid by half seed (cereal) method.
3. Seed viability test.
4. Estimation of total auxins, cytokinins and Gibberellins in plant material.
5. Effect of IAA on rooting.
6. Hormonal effects on senescence.

Reference Books:

1. Introductory Plant Physiology, 2nd Edition G. Ray Noggle (Emeritus),George J. Fritz. Prentice Hall of India. 2002.
2. Plant Physiology; Sebanek J. Sebanek. Elsevier Science & Technology. 1992.
3. Plants Under Stress: Biochemistry, Physiology and Ecology and Their Application to Plant Improvement; Hamlyn G. Jones, T. J. Flowers, M. B. Jones. Cambridge University Press. 2008.
4. Biochemistry & Molecular Biology of Plants; Eds: Bob Buchanan, Wilhelm Gruissem, Russell Jones (Editor) Wiley; 1st. edition. 2002.
5. Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants. M. N. V. Prasad, Kazimierz Strzalka, M. N. V. Prasad. Springer. 2002.
6. Plant Hormones: Physiology, Biochemistry and Molecular Biology: P. J. Davies Peter J. Davies. Kluwer Academic Publishers. 1995.
7. The Physiology of Flowering Plants; Opik, Helgi. Cambridge University Press.
8. Text book of Plant Physiology. V. Verma. Ane Books. New Delhi. 2007.
9. Plant Physiology; R.M. Devlin & Witham. Reinhold publications. 1969.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17

Core course 9: *M3BOT01-CT09*

Paper I: *Plant Physiology*

Unit-I Credit hours: 12

Photosynthesis: Historical account, Evolution of photosynthetic apparatus, physiological and ecological significance, Factors effecting photosynthesis. Photo pigments; types, structure, Photosystems; types, structure and function. Photophosphorylation. Photo-protective mechanisms. Carbon assimilation; C_3, C_4 and CAM pathways, Photorespiration and its significance.

Unit-II Credit hours: 12

Respiration: Over view, Historical account, Evolution of anaerobic and aerobic metabolism, Aerobic respiration: glycolysis, TCA cycle, Pentose phosphate pathway, Oxidative electron transport and chemiosmotic hypothesis of ATP synthesis, alternative oxidase system, Anaerobic respiration. Fermentation: Alcohol and Lactic acid fermentations. Gluconeogenesis

Unit-III Credit hours: 12

Lipid and Nitrogen metabolism: Oxidation of Fatty acids, β-oxidation, Ketone Bodies, ammonium assimilation (reductive amination, GS-GOGAT system, transamination).
Biological nitrogen fixation: Non symbiotic and Symbiotic, nitrification and denitrification. Structure of nodule and heterocyst, Role and structure of Nitrogenase, Leghemoglobin, Genetics of Nitrogen fixation.

Unit-IV Credit hours: 12

Secondary metabolism: Function and uses of Glycosides, anthraquinones, isothiocynates, flavonols, lactones phenols, saponins, cardiac glycosides. Alkaloids, indoles, isoquinolines, tropanes, pyridine and piperidine, steroidal alkaloids. Phenols and Tannins.

Unit-V Credit hours: 12

Stress physiology: Types of stress and physiological consequences, Response and resistance mechanisms, Molecular mechanism of tolerance, Stress tolerant Transgenics.

Heat stress and heat shock proteins, Osmotic adjustments, Reactive oxygen species and oxidative stress, Metal toxicity. Biotic stress and response, HR and SAR mechanisms.

Practicals

1. Determination of water potential of plant tissue by falling drop method.
2. Determination of osmotic potential of cell sap.
3. Determination of osmotic potential of cell sap by plasmolytic method.
4. Demonstration of mechanism of opening and closing of stomata.
5. Determination of the rate of transpiration.
6. Study of effect of plant hormone on rate of transpiration.
7. Demonstration of osmosis by using egg membrane.
8. Effect of osmotic potential of external solution on the rate of imbibition.
9. Determination of stomatal index, frequency and pore area.
10. Effects of chemicals and temperature on the permeability of protoplasmic membrane.
11. Estimation of water content, dry matter and ash content of plant.

Reference Books

1. Plant Physiology; Lincoln Taiz and Eduardo Zeiger, Sinauer Associates; 3rd ed. 2002.
2. Introduction to Plant Physiology; William G. Hopkins and Norman P. A. Huner. Wiley; 3 Ed., 2003.
3. Plant Physiology; Frank B. Salisbury and Cleon Ross. Brooks Cole; 4th edition 1992.
4. Water Relations of Plants, Paul Jackson Kramer. Academic Press. May 1983.
5. Plant Stress Biology: From Genomics to Systems Biology. Wiley-VCH, 2009.
6. Plant Abiotic Stress (Biological Sciences Series); Eds: Matthew A. Jenks and Paul M. Hasegawa. Wiley-Blackwell, 2005.
7. Plant Physiology; Eds; Meirion Thomas. Prentice Hall Press; 5th edition. 1973.
8. 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.
9. 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.
10. Plant Physiology; Hans Mohr, Dr Hans Mohr, Hans Mohr. Springer. 1995.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17)

Core course 10: *M3BOT02-CT10*

Paper II: *Plant Systematics and Resources Utilization*

Unit-I Credit hours: 12

Fundamentals of Systematics: Historical account of development of Taxonomy, Plant nomenclature, Taxonomic structure (concept of taxa, species, genus, family), numerical taxonomy, Botanical gardens, Herbarium, Taxonomic terminology; floral formula and floral diagram. Phylogeny; origin and evolution of angiosperms

Unit –II Credit hours: 12

Systems of angiosperm classification – broad outline and relative merits and demerits of major systems of classification (Bentham and Hooker; Engler and Prantl; Hutchinson; Takhtajan; Angiosperm Phylogeny Group).
Taxonomic evidence – Role of morphology, anatomy, embryology, palynology, phytochemistry, molecular systematics

Unit –III Credit hours: 12

Angiosperm families: Range of floral variation and trends of evolution in the Ranunculaceae, Malvaceae, Brassicaceae, Leguminosae (Subfamily; Papilionoideae, Caesalpinioideae, Mimosoideae), Solanaceae, Asteraceae, Cucurbitaceae, Apocynaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Poaceae.

Unit –IV Credit hours: 12

Ethnobotany: Introduction, History and development of ethnobotanical study; scope and potential applications; methods in ethnobotanical study. Applied Ethnobotany and intellectual property rights.

Economic Botany: Origin, evolution, Botany, cultivation and uses of fibre yielding plants, cereal crops, sugar yielding plants, pulses, oil yielding plants.

Unit –V Credit hours: 12

Economic Botany: Origin, evolution, Botany, cultivation and uses of fruits and nuts, vegetables, spices, condiments, beverages, medicinal plant, rubber yielding plants and petrocrops. Centres of origin.

Practicals:

(i) Study of at least 20 locally available families of flowering plants
(ii) Identification of genus and species of locally available wild plants
(iii) Preparation of botanical keys
(iv) Training in using floras and herbarium for identification of specimens described in the class.
(v) Field trips within and around the campus, compilation of field notes and preparation of herbarium sheets of such plants.
(vi) Knowledge of at least 25 plant species of economically and traditionally important plants.

Reference books:

1. Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.
2. Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
3. Gurcharan Singh. 2004. Plant Systematics : Theory and Practice Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Heywood (ed.) Modern Methods in Plant Taxonomy.
5. Jones, S.B., Luchsinger, A.L.1987. Plant Systematics.
6. Judd Walter S., Campbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics: A phylogenetic approach. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
7. Lawrence, George H. M. 1951. Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi
8. Nordenstam, B., EI Gazaly, G. and Kassas, M. 2000. Plant Systematics for 21st century.
9. Quicke, Donald, L. J. 1993. Principles and Techniques of Commemoratory Taxonomy. Blakie Academic and Professional, London
10. Radford, A.E. 1986. Fundamentals of Plant Systematics, Harper & Row Publ. USA.
11. Stace, C. A. 1980. Plant Taxonomy and Biosystematics Edward Arnold, London.
12. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia Univ. Press, New York.
13. Tiagi, Y.D. and Aery, N.C. Flora of Rajasthan (South and South -east Region). Himanshu Publications, New Delhi, Udaipur.
14. Woodland, D.W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey.
15. Katewa, S.S. & Jain Anita. Ethnobotany, Phytogeography, Plant Resources Utilization and conservation. Apex Publishing House, Jaipur. 2007.
16. Kocchar, S.L. 1998. Economic Botany of the Tropics, 2nd edition, Macmillan India Ltd., Delhi.

17. Nair, M.N.B. et al. (eds) 1998. Sustainable Management of Non-wood Forest Products. Faculty of Forestry, University Putra Malaysia, 434004 PM Sardong, Selanger, Malaysia.
18. Paroda, R.S. and Arora, R.K. 1991. Plant Genetic Resources Conservation and Management. IPGRI (Publication), South Asia Office, C/o NBPGR, Pusa Campus, New Delhi.
19. Plant Wealth of India 1997. Special Issue of Proceedings Indian National Science Academy B-63.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –IV (2016-17)

Core course 11: ***M4BOT01-CT11***

Paper I: ***Genetic Engineering of plants***

Unit-I Credit hours: 12

Recombinant DNA Technology: – Gene cloning principles and techniques (Plasmid, phage, cosmid, construction of genomics/ cDNA libraries, choice of vectors. Restriction enzymes. Restriction mapping- concept and techniques. DNA sequencing, PCR, Northern and Southern blotting, RFLP, RAPD, AFLP based DNA finger printing, microarrays. Integration and expression of foreign genes in pro- and eukaryotes. Site-directed mutagenesis.

Unit-II Credit hours: 12

The Genetics of RNA: Catalytic diversity of RNAs, RNA silencing in plants, Cross talk between RNA metabolic pathways- an RNomics approach. Alternative splicing. Ribozyme, siRNA libraries. Non-coding RNA and gene silencing, Epigenetics Prions of yeast as epigenetic phenomena.

Unit-III Credit hours: 12

Genetic Engineering of Plants: Methods of direct and *Agrobacterium* mediated gene transfer, electroporation, microinjection, particle-gun technology. Chloroplast transformation and its utility. Transgenic plants: performance and fortification of agricultural products–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 ad ethical issues associated with GM crops and GM food. Labeling of GM plants and products.

Unit-IV Credit hours: 12

Applications: Gene therapy: Principles and different strategies, Gene therapy for inherited diseases, stem cell based therapy and tissue engineering, Ethical and social considerations, genome projects, Basics of protein engineering and design. Production of Industrial enzymes, biodegradable plastics, therapeutic proteins.

Unit-V Credit hours: 12

Applications: Molecular mechanisms and differentiation of T4-DNA, Seed and Cell bank, Biosensors, Biochips, Hybridoma technology, production of edible vaccines and antibiotics using transgenic technology, Nucleic acid probes, Brief idea of Animal vaccines, Cryopreservation, germplasm collection and conservation, Brief idea of plant tissue culture certification. Terminator gene technology. Environmental impact of herbicide resistance crops and super weeds.

Practicals:

1. Isolation of plant genomic DNA, its purification and visualization.
2. Isolation of plasmid DNA and genetic transformation of bacterial cells using competent *E. coli*.
3. Preparation of master-mix and setting of PCR reaction.
4. RAPD and ISSR markers.
5. Demonstration of particle gun technology and model.
6. SDS-PAGE and its use in protein profiling and analysis.
7. Culture of *Agrobacterium tumefaciens* on agar-plate and broth.
8. Co-culture of *Agrobacterium* with plant explants.
9. Gus assay for genetic transformation.
10. 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 (2016-17)

Core course 12: *M4BOT02-CT12*

Paper II: *Analytical Techniques in Plant Sciences*

Unit-I Credit hours: 12

Microscopy: Optical, phase contrast, Fluorescence and electron microscopy (TEM and Scanning); Centrifugation-Principle; Ultra centrifugation.
Electrophoretic techniques:Principle, types of instruments, resolution, separation and application, isoelectric focusing.

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, Biological Sequence Databases; National Center for Biotechnology Information (NCBI), EMBL Nucleotide Sequence Database (EMBL-Bank), DNA Data Bank of Japan (DDBJ), Protein Information Resource (PIR), Swiss-Prot. Applications of Bioinformatics.

Unit-IV Credit hours: 12

Biostatistics: Variables in biology, collection, classification and tabulation of data. Graphical and diagrammatic representation, Measures of central tendency – Mean (arithmetic, harmonic and geometric), Median and Mode.

Unit-V Credit hours: 12

Biostatistics: Measures of dispersion: Standard deviation and standard errors; skewness and kurtosis; Correlation and Regression. Analysis of variance (single factor analysis), chi-square test, type of errors; levels of significance, probability distributions (Binomial, Poisson and normal).

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. Perform BLAST using NCBI tool
4. Design Primer using various primer designing softwares.
5. Sequence retrieval from databases.
6. Multiple Sequence alignment and Construction of phylogenetic tree.

Reference Books:

1. Practical Biochemistry: Keith Willson and John Walker, Cambridge University Press.
2. Physical Biochemistry: David Friefelder.
3. Instrumental methods of chemical analysis: Chatwal and Anand, Himalaya Publishing House.
4. Instrumental Methods of Chemical Analysis: B.K. Sharma, Goel Publishing House.
5. X-Ray Methods: C. Whiston.
6. The Electron Microscope in Biology: A.V. Grimstone.
7. Tertiary Level Biology- Methods in Experimental Biology: R. Ralph Blackie.
8. Animal Tissue Technique: G.L. Humason.

9. NMR and Chemistry: J.W. Akitt, Chapman and Hall.
10. S. C. Gupta. Fundamentals of Statistics. Himalaya Pub. House.
11. J. Medhi. Statistical Methods an introductory text. New Age International (P) Ltd. Publishers.
12. P. S. S. Sudar Rao & J. Richard. An introduction to biostatistics. Prentice Hall of India. N. Delhi.
13. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
14. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT01-ET01A
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

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT01-ET01B

Bioinformatics

Unit-I Credit hours: 12

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: 12

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: 12

Information Retrieval: LAN, WAN, Introduction to Internet, WWW, NICNET, ERNET, VSNL, ISDN, E-mail, Publication on worldwide web, on-line publishing ventures eg. Biomed, online international database access.

Unit-IV Credit hours: 12

Biological Databases: Primary Sequence databases (Protein and DNA databases), Secondary databases, Composite databases.
Sequence Alignment and Databases searching: Evolutionary basis of sequence alignment. Optimal Alignment methods, Substitution Scores and Gap penalties.

Unit-V Credit hours: 12

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.

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

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT01-ET01C

Secondary Metabolite Production

Unit-I Credit hours: 12

Secondary metabolites: Principal classes of secondary metabolites (alkaloid, terpenes, phenolics), shikimic acid and mevalonate pathways. Bioactive molecules from plants, fungi and microorganisms.

Unit-II Credit hours: 12

Production of secondary metabolites: Nutrients and media, approaches and factors affecting the production of secondary metabolites (optimization, selection, hairy roots, elicitation, concept of growth and production media).

Unit-III Credit hours: 12

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. Bioconversion of molecules by cell free system, and cell cultures, freely suspended and immobilized cells and enzymes.

Unit-IV Credit hours: 12

Molecular farming: production of drugs by genetic engineering technology, metabolic engineering for the production of useful metabolites. Methods of extraction and isolation of secondary metabolites: alkaloids, polyphenolics and terpenes and their tests.

Unit-V Credit hours: 12

Bioreactors: types of bioreactors (stirred tank, air lift, membrane type, immobilized cell bioreactors), process and operation. Bioreactor for production of biomass (secondary metabolites and for micropropagation), mass-scale for commercialization. Plant tissue culture industry in India.

Practicals:

1. Extraction and preparation of crude extract for value addition.
2. TLC of various compounds – alkaloids, food additives.
3. Handling of spectrophotometer and __max determination.
4. HPLC profile of selected material.
5. Column chromatography for isolation of pure compound.
6. Identification of local medicinal plants and their usage.
7. Quantitative tests for alkaloids, steroids, terpens, phenolics etc.

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.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT01-ET01D
Biosystematics

Unit-I Credit hours: 12

Experimental Taxonomy: Classical vis-à-vis experimental taxonomy, scope and significance of experimental taxonomy, principles and procedures of biosystematics, experimental taxonomic categories, Deme terminology. Concept of species, origin and evolution of species, speciation in vegetatively reproducing plants, speciation in relation to breeding systems. Concept of character, adaptive significance of major taxonomic characters and morphological trends in angiosperms, a general account of numerical taxonomy.

Unit-II Credit hours: 12

Population and Speciation: Population concept, variation within population, causes of variation in populations; polymorphism and gene flow within population. Population and the environment: phenotypic plasticity and range of tolerance, ecotypes, transplant experiments. Hybridization: recognition of hybrids, isolation mechanisms, hybrid swarms and introgression, taxonomic treatment of hybrids.

Unit-III Credit hours: 12

Biosystematics and conservation: Endangered taxa and their conservation with special reference to India, Hot spots; Biosystematics and conservation. Evolution and migration of flora, taxonomy of cultivated plants; Plant explorations, invasions and introductions; Local plant diversity and its socio-economic importance

Unit-IV Credit hours: 12

Taxonomic tools: Herbarium, flora, histological, cytological, phytochemical, serological, biochemical and molecular techniques; Computer and GIS. Role of the following

disciplines in modern taxonomy: Morphology, Anatomy, Embryology, Phytochemistry, Cytology, Palynology, Genome analysis, Nucleic acid hybridization

Unit-V Credit hours: 12

Case studies: Taxonomic and morphological characteristics of the following : *Paeonia, Exocarpus, Trapa, Sphenoclea, Nyctanthes, Funaria, Calycanthus, Polygala, Aristolochia, Casuarina, Passiflora, Centella, Dischidia, Ultricularia, Tillandsia, Butomus, Butomopsis, Alisma.*

Practical:

1. Descriptions, sketching, classification and identification of wild and cultivated plants represented in local flora.
2. Methods of preparation of herbarium
3. Methods of preparation of digital herbarium
4. Exercises on nomenclature problems: Author citation, Principle of Priority, transfer of taxa, effective and valid publication etc
5. Describing new taxon, deposition of type, Latin diagnosis and abbreviations used in citations.
6. Preparation and use of Botanical keys
7. Practical based on numerical taxonomy
8. Study of Exotic plants found in the region
9. Study of Endemic plants of India in light of IUCN Red List Categories.
10. Semipermanent pollen preparations by acetolysis method and study of different pollen morphotypes.
11. Study of chomosomes, chromosome banding and Karyotype analysis
12. Interpretation of phytochemical data for taxonomy

Reference Books:

1. Bhojwani, S. S. and Bhatnagar, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Delhi.
2. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
3. Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.
4. Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tommorow Publications, New Delhi.
5. Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Almquist and Wiksell. Stockholm.

6. Fahn. 1979. Plant Anatomy.
7. Hutchinson, J. 1959. Families of Flowering plants.
8. Johri, B. M. 1984. Comparative embryology of Angiosperms. Ind. Nat. Sc. Acad. New Delhi.
9. Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts,USA.
10. Lawrence George H. M. 1951. Taxonomy of Vascular Plants. Oxford and IBH Publ.Co. Pvt. Ltd. New Delhi .
11. Maheshwari, P. 1985. An Introduction to Embryology of Angiosperms. Tata McGraw Hill. New Delhi.
12. Nair, P. K. K. 1966. Pollen morphology of Angiosperms. Periodical Expert Book Agency, New Delhi.
13. Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
14. Quicke, Donald, L. J. 1993. Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London.
15. Shivanna, K. R. and N. S. Rangaswamy. 1992. Pollen Biology- A Laboratory Manual. Springer-Verlag
16. Sharma Arunkumar and Archana Sharma. 1980. Chromosome Technique: Theory and Practices (3rd ed.) Butterworths, London.
17. Taylor, D. V. and L. J. Hickey 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.
18. Takhtajan, A. 1962. Flowering plants- Origin and Dispersal.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT02-ET02A
Plant Tissue Culture

Unit-I Credit hours: 12

History: Scope and applications, Historical account of development of plant tissue culture; Contributions of P. R. White, R. J. Gauthret, J. Reinert, F. C. Steward, G. Morel, E. C. Cocking, P. Maheshwari, B. M. Johri, I. K. Vasil, Vimla Vasil, S. C. Maheshwari, Sipra-Guha Mukherjee. Concept of cell totipotency, cellular differentiation and morphogenesis, molecular basis of *in vitro* differentiation.

Unit-II Credit hours: 12

Tools and techniques: Concept of asepsis and methods of sterilization-physical and chemical methods of sterilization, Principle, construction and operation of instruments used in plant tissue culture- pH meter, ovens, Laminar Flow Clean Air Bench, Glassbead sterilizer, Lux meter, Magnetic stirrer etc. Explant selection, preparation and initiation of cultures, callus and suspension cultures, single cell culture, measurement of growth characteristics (cell size, types, number, viability, fresh and dry weight, PCV etc.)

Unit-III Credit hours: 12

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. Stages of micropropagation. Micropropagation in forestry and horticulture.

Unit-IV 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. Role of plant tissue culture in crop improvement. Virus elimination and culture of obligate parasites.

Unit-V Credit hours: 12

Secondary plant metabolites: Production by use of cell culture technology. Bioreactors, types and uses. Hairy root culture, cell immobilization. Synthesis, Function and Uses,

General methods of phytochemical analysis, methods of extraction, isolation, separation, identification and analysis of following: Glycosides: anthraquinones, isothiocynates, Flavonols, Lactones, Saponins and cardiac glycosides. Alkaloids: indoles, isoquinolines, tropanes, pyridine and piperidine, steroidal alkaloids. Phenols and Tannins.

Practicals:

1. TLC of plant pigment/ colored food additives (Anthocyanin/ curcuma).
2. TLC of alkaloid/ guggulsterone, use of TLC documentation system.
3. HPLC separation of secondary products, preparation of sample for HPLC (dilutions, filtration by membrane, loading and calculation of data).
4. Determination of UV lambda max by spectrophotometer.
5. Organized culture subculture in liquid medium: root/ shoot/hair roots.
6. Hairy root culture: co-culture method.
7. Somatic embryogenesis.
8. Column chromatography procedure for separation of secondary metabolites.
9. Anther culture for haploids.
10. Observation of cells under visible/ fluorescence microscope.
11. Explant preparation.
12. Medium preparation.
13. Shoot culture technique and regeneration.
14. Separation of shoots in organized culture.
15. Hybridization techniques - Emasculation, Bagging (For demonstration only).
16. Induction of polyploidy conditions in plants (For demonstration only).
17. Dissertation

Reference Books:

1. Bhojwani S.S. and Razdan M.K. (1983). Plant Tissue Culture: Theory and Practice. Elsevier, Amsterdam.
2. Razdan M.K., 2002. Introduction to Plant Tissue Culture. Oxford & IBH.
3. Reinert J. and Bajaj Y.P.S.1977. Plant Cell Tissue and Organ Culture. Springer Verlag.
4. Bhojwani S.S. 1990. Plant Tissue Culture: Application and Limitations. Elseiver.

5. Narayanswamy. 1994. Plant Cell and Tissue Culture. East-West Press.

6. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

7. Purohit, S.D. 2013. An Introduction to Plant Cell, Tissue and Organ culture. Prentice Hall, India.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT02-ET02B

Biology and Evolution in Bryophytes

Unit-I Credit hours: 12

Introduction, characteristics and classification, Evolution of gametophyte and sporophyte of bryophytes. 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

Bryophytic 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, Microtechniques in bryological studies

Practicals:

Practicals will be based on theory course contents.

Reference Books:

1. Introduction to Bryology. Vol.I and II. W.B. Schofield, University of British Columbia.
2. Bryophyte Development: Physiology and Biochemistry. Chopra R.N., Satish C. Bhatia. CRC Press.
3. An introduction to Bryophyta. A. Rashid. Vikas Publications. New Delhi.
4. British Mosses and Liverworts. Cambridge Watson. E.V.
5. Cryptogrmic Botany. Vol. II. Smith G.M.
6. Liverworts of the Western Himalayas and the Punjab Palm Part I. University of Punjab, Lahore.
7. Biology of Bryophytes. R.N. Chopra & S.C. Bhatia.
8. Taxonomy of Indian Mosses. R.S. Chopra.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT02-ET02C
Agrostology

UNIT – I Credit hours: 12

Gramineae: Distribution, Habit, Root, Stem, Leaf, Inflorescence, fruit, seed and Embryo. Relationship of the Gramineae. Evolution in Gramineae: Evolution of spikelets Floral evolution, structure and evolution of Gynoecium. Grass Systematics: Sub families, tribes and sub-tribes.Anatomy of Grass leaf and stem

UNIT – II Credit hours: 12

Grasslands: Grassland Environment including Micrometeorological Parameters: Humidity, Absolute humidity, Specific humidity, Relative humidity, Vapour pressure and Measurement of humidity.Soil and soil forming process operating in Grasslands.Root system of plants of grasslands. Ecological amplitude of various constituent species of grasslands. Chemical composition and fodder value of Indian Grasses.

UNIT – III Credit hours: 12

Grassland research: Institutions of Grassland research in India: Their aims, objectives and achievements. Grasslands and National Economy: Grassland as supplier of fodder, Role of grasses in checking soil erosion, stabilization of sand dunes, Thatching, Oil, Khas khas; Grassland and defence, wildlife management, food for human consumption.
Socio-economic importance of Grasses in the life of indigenous people of Rajasthan. Threats to the grasslands of Indian desert.

UNIT – IV Credit hours: 12

Pastures: Importance, status and research needs of pastures; pasture establishment, improvement and renovation of natural pastures, cultivated pastures and common pasture grasses; Scope of grassland ecology; grassland climate, Basis of grassland classification, phytogeography of grasslands, major grassland types, grasslands in India with special reference to Rajasthan. Ecological status of grasslands in India.

UNIT – V Credit hours: 12

Grassland as an ecosystem; Dynamics of grassland ecosystem, nutrition of grasslands, Grass-legume association; Ecology of fire in grasslands; Grasses and grasslands in relation to soil conservation; management of grasslands.

Practicals:

1. Study of Morphological and Anatomical Characters of Grass Stem, Root and Leaf.
2. Study of types of inflorescence of family Poaceae.
3. Study of Spikelet of Grasses.
4. Mechanical analysis of Grassland soil.
5. Determination of the pH of Grassland soil.
6. Study of Grassland vegetation by Quadrat method.
7. Study of Grassland vegetation by line transect method.
8. Study of Grassland vegetation by point frame.
9. Study of Grassland vegetation by the point – centered quarter method.
10. Comparison of grassland communities under various stresses of biotic impacts.
11. Determination of total biomass in a Grassland community.
12. Study of primary productivity of a Grassland vegetation.
13. Determination of organic matter of Grassland soil.
14. Determination of chlorophyll content of Grassland species.
15. Determination of Forbes and grass ratio of Grassland by random count method.
16. Determination of Inter and Intraspecific relations of the Grassland species.
17. Study of Reproductive capacity of Grassland species.
18. Study of seed Germination of grass species.
19. Determination of leaf area index.
20. Study of microflora of Grassland soil.

Reference Books:

1. Grass Systematics by Frank W. Gould.
2. Grassland and Fodder Resources of India by R.O. Whyte.
3. Forage Crops of India by Dabadghao and Shankarnarayan.
4. Grass cover of India by Shankarnarayan.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –III (2016-17)

Discipline Specific Electives

M3BOT02-ET02D

Industrial Biotechnology and Bioprocess engineering

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: batch culture, fed-batch culture and continuous culture. Solid state fermentation. Air and Media sterilization. Microbial growth kinetics and measurement of growth. Factors affecting growth. Isolation, preservation and improvement of industrially important microbes. Media for industrial fermentation. Inoculum development.

Unit-III 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.
Industrial production of microbial biomass, enzymes, primary and secondary metabolites. Enzyme and cell immobilization and their industrial applications.

Unit-IV Credit hours: 12

Applications: Industrial application of recombinant DNA technology using microbes. Microbial polysaccharides and polyesters. Production of Single Cell Proteins (SCP). Microbial transformation of steroids and sterols. Use of microbes in bioprospecting, oil recovery, bioremediation, biomining. Effluent treatment and disposal of effluents.

Unit-V Credit hours: 12

Microbial Food Technology: Concept, Microbiology of food products. Principles of Food preservation: Contamination, spoilage and preservation of different kinds of foods. Sterilization and Pasteurization. Fermented foods. Probiotics. Elementary idea of canning and packing. Food sanitation, control and inspection.

Practicals:

1. Study of principle and working of important instruments used in industrial and bioprocess engineering.
2. Designing of a simple Lab fermenter.
3. Study of growth kinetics of bacteria.
4. Study of effect of physical factors on growth of production strain.
5. Study of effect of chemical factors on growth of production strain.
6. Study of effect of inoculum size on growth.
7. Study of effect of UV radiation on microbial growth.
8. Study of effect of chemical disinfectants on microbial growth.
9. Isolation and purification of microbial metabolites
10. Improvement of production strains.
11. Study of production of organic acids from bacterial strains.
12. Study of immobilization of enzymes.
13. Isolation of antibiotic producing microbes from soil.
14. Antibiotic sensitivity test.
15. Isolation of industrially important microorganisms for microbial processes.
16. To test the production of enzymes: Amylase, proteinases, lipases and celluloses by microorganisms.
17. Demonstration of citric acid production by *Aspergillus niger*.
18. Methylene blue reductase test to determine the quality of milk sample.
19. Study of food-spoilage microorganisms in fresh, canned, fermented food and meat.
20. Production and analysis of SCP: *Spirulina*, yeast, *Chlorella*, mushroom.
21. Production of yoghurt using specific starter cultures.
22. Preparation of alcohol from fruit juices.
23. Removal of microbial cells from a solution by membrane filtration method.
24. Determination of phenol coefficient.
25. Dissertation

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. Food Microbiology; William C Frazier and Dennis C. Westhoff. Tata Mgraw Hill. 2008.
3. General Microbiology; R.C. Dube and D. K. Maheswari. S Chand , New Delhi. 2000.
4. Microbiology; M.J., Prescott, J.P Harley and D.A. Klein.. 5th Edition, WCB Mc GrawHill, New York. 2002.
5. General Microbiology; R.Y. Stanier, E.A. Adelberg and J.L. Ingram. 5th Ed., Prentice Hall of India Pvt. Ltd., New Delhi. 1991.
6. Introduction to Microbiology; A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
7. Microbiology: Principles and Explorations, J.G. Black, John Wiley, USA.2005.
8. A Text Book of Microbiology: R. C. Dubey and Maheshwari. S Chand & Company Ltd. 2009.
9. Principles of Fermentation Technology; P F Stanbury , S. Hall , A. Whitaker. Butterworth-Heinemann; 2 edition. 1999.
10. Microbiology: an Introduction, G.J. Tortora. R.F. Burdell and C.L. Case. Benjamin-Cummings Publishing Company. 1989.
11. Industrial Microbiology: An Introduction; M.J. Waites, N. L. Morgan, N. L. and G. Higton, Wiley-Blackwell. 2001.
12. Experiments in Microbiology, Plant pathology and Biotechnology, K. R. Aneja. New Age international Publishers, 2004.
13. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
M. Sc. BOTANY SEMESTER –IV (2016-17)

Discipline Specific Electives

M4BOT03-ET03A
Advanced Plant Pathology

Unit-I Credit hours: 12

Disease: History and significance, General definitions and terminology. Concept of disease: Parasites, parasitism, pathogen, pathogenicity, Fundamental concepts of plant pathology. Inoculum; Source: primary and secondary, Inoculum potential. Epidemiology: epidemic and sporadic diseases. Epiphytotics. Disease forecasting, Factors affecting plant diseases: abiotic; soil, climatic, other physical factors, Methods of studying, plant pathogens, Koch's Postulates, Isolation and identification of pathogens

Unit-II Credit hours: 12

Pathogenesis: Penetration of host, Plant disease development and symptoms, Transmission of disease. Resistance to plant pathogens: Types of resistance; horizontal vertical resistance. Deranged physiology with special reference to phenolics, carbohydrates, enzymes, plant growth regulators and other metabolites, Molecular basis of pathogen virulence and host resistance, gene-for-gene concept. Role of toxins and phytoalexins in disease development.

Unit-III Credit hours: 12

Pathogens: Study of symptoms, etiology, perpetuation and control measures of common fungal, bacterial, viral and phytoplasma induced disease with special reference to Wheat, Maize, Bajra, Sesame, Groundnut, Sugarcane, Cowpea, Gram, Tomato, Potato, Chillies, Lemon etc. diseases specially with respect to regional crops and vegetables. Plant galls: insect and mite induced galls, types, classification, structure, effect on host physiology. Nematodes as plant-parasites or pathogens of plants, Host response and symptoms, Important plant- parasitic nematodes and diseases, Control of plant-parasitic nematodes.

Unit-IV Credit hours: 12

Plant disease management: Concept: Principles and practice, Prophylactic approach, Eradication, Prevention. Quarantine, some examples of Agri-quarantine measures. Chemical control; classification and types of formulations, additives, application, equipment, and calibrations transportation, handling, storage and disposals.Chemical

groups, structure, formulation and methods of application. Bioassay tests and formulation stability.

Unit-V 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. Biocontrol agents, Commercial products and application

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. Study of the effect of fungicides on the germination and growth of plant pathogenic fungi.
5. Isolation of nematode from soil & study of their histology.
6. Study of diseases with respect to host, casual organism, symptoms.
7. Isolation and pure culture development of plant pathogenic fungi and bacteria.
8. Identification of plant pathogenic fungi and bacteria.

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

M. Sc. BOTANY SEMESTER –IV (2016-17)

Discipline Specific Electives

M4BOT03-ET03B

Stress Physiology

Unit-I Credit hours: 12

Stress: Introduction and General Concepts, Environmental conditions that cause stress. Phytotoxic compounds, Resistance or sensitivity of plants to stress, Stress resistance mechanisms, response to environmental stress, molecular basis of response. Regulation of plant stress responses: Abscisic acid (ABA), Jasmonic acid, Ethylene, Calcium, Genetic engineering for various stresses. Problems of water, temperature, salt, water logging and pollution stresses internationally and nationally.

Unit-II Credit hours: 12

Water Stress: Water status of plants, causes of water deficit and its physiological consequences, Mechanism of salt stress, physiological responses of plants to salinity stress, Tolerance to drought and salinity, Molecular and genetic basis of drought and salinity resistance. Osmotic adjustment,Compatible solutes (osmolytes), Compatible ions, Proline & glycine betaine, Mannitol, D-Pinitol, Osmotin. Effect of water deficit on membrane transport. Additional genes induced by water stress, Breeding for drought resistance, Drought hardening.

Unit-III Credit hours: 12

Heat stress: Conditions that cause heat stress, physiological consequences of heat stress, Resistance or sensitivity of plants to heat stress, Heat avoidance and tolerance, molecular aspects of thermo-tolerance. Heat shock proteins and their role in stress resistance.
Freezing stress: Effect of low temperature on plant metabolism, freezing process, freezing injury, Cold hardening, Acclimatization to low temperature, Freezing resistance; types, measurements and changes, factors related to freezing tolerance, molecular basis of freezing injury and tolerance.

Unit-IV Credit hours: 12

Radiation stress: Influence of high light intensity on photosynthesis, photoprotection mechanisms, Effect of UV radiations on plants, Mechanism of UV tolerance.
Flooding stress: Nature of water logging stress, Effect of flooding stress on physiological processes of plants, acclimatization to flooding.
Oxidative Stress: factors that cause oxidative stress, Reactive oxygen species (ROS) and oxidative stress. Effects of ozone on plants, Ozone Damage, Resistance to ozone. Tolerance to oxidative stress. Salicylic acid and ethylene.

Unit-V Credit hours: 12

Biotic stress: Influence of Plant Pathogens on Host Physiology, hypersensitive response (HR), Role of secondary metabolites, NO, Benzoic acid and salicylic acid, ROS, Jasmonic acid and Ethylene in plant defence, Pathogenesis-related (PR) proteins, Plant defensins, Pytoalexins, Systemic plant defence responses, Systemic acquired resistance (SAR), Induced systemic resistance (ISR).
Anthropogenic stress: Soil Pollutants (heavy metals and pesticides), functional and ecological aspects of heavy metal stress on plants, physiology of heavy metal toxicity in plants, phytoremediation, Mechanism of heavy metal tolerance, pesticide stress. Atmospheric stressors (air pollutants; SO_2, O_3, NO_2, Greenhouse Gases and elevated CO_2 levels).

Practicals:

1. Determination of water potential of plant.
2. Measurement of salinity of given soil.
3. Measurement of relative water content and osmotic potential.
4. Determination of chlorophyll stability index.
5. Estimation of chlorides in leaves of halophytes and non halophytes.
6. Study of protein/amino acid profile in plants under stress.
7. Study of effect of fungal infection on peroxidase activity.
8. Study of phenolics in scales of onion varities differing in disease resistance.
9. Study of free radical scavenging enzymes, catalse and super oxide dismutase.
10. Study of free proline accumulation in plants under stress.
11. Study of seed germination under stress condition.
12. Determination of water potential by gravimetric method.
13. Effect of temperature and chemicals on membrane permeability.
14. Study of rate of transpiration under different environmental factors.
15. Study of rate of photosynthesis under different light intensities.
16. To test the germination capacity of seeds using Tetrazolium chloride.
17. Measurement of pH of expressed cell sap and different soils using pH meter.
18. Determination of ratio of water absorption and transpiration by weighing method.
19. Study of effect of temperature on seed germination.
20. Study of effect of salt stress on protoplasm.

Reference Books:

1. Singhal *et al*. 1999. Concepts in Photobiology, Photosynthesis and Phytomorphognesis, Narosa Pub. House, New Delhi.
2. Plant Physiology Taiz and Zeiger, Sinauer Associates Inc., Publishers, Sunderland.

   1998.
3. Devlin and Witham, 1986. Plant Physiology. CBS Publishers and Distributors, New Delhi.
4. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and molecular Biology of plants. American Society of Plant Physiologists
5. Physiological Plant Ecology : Ecophysiology and Stress Physiology of Functional Groups. Springer-Verlag. Larcher, W. 2004.
6. Plant Physiological Ecology. Lambers, H, Chapin III, F.S. and Pons, T.L. Springer. 1998
7. Introduction to plant physiology. Hopkins, W.G and Huner, 2004..
8. Fitter AH and Hay, R.K.M. 2001. Wiley. Environmental Physiology of Plants 2nd Edition.Academic Press.
9. The Physiology of Plants Under Stress, Soil and Biotic Factors. D.M. Orcutt and E.T. Nilsen. John Wiley and Sons, Inc., 605 3rd Avenue, New York, NY
10. Physiological Plant Ecology: ecophysiology and stress physiology. Walter Larcher. Springer, New York. 2003.
11. Stress Physiology. D. P. Singh.New Age International Pvt. Ltd., New Delhi, 2003.
12. Plant response to abiotic stress. Heribert Hirt, Kazuo Shinozaki. Springer-Verlag Berlin Heidelberg, Germany. 2004.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –IV (2016-17)

Discipline Specific Electives

M4BOT03-ET03C

Environmental Monitoring, Management and Restoration

Unit-I Credit hours: 12

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: 12

Environmental management: Introduction and scope of, basic concepts of sustainable development. Survey and classification of natural resources; conservation; management of resources: Management and utilization of inland freshwater resources; management of forest resources. Biomass as a source of energy, non-conventional sources of energy.

Unit –III Credit hours: 12

Biological diversity: Threats to biodiversity, major causes of extinction, vulnerability of species to extinction, IUCN threat categories, Red data book. Strategies for biodiversity conservation, 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: 12

Waste management: Solid Waste; Sources and management; Composting and methane production; Hazardous waste; Disposal and management of radioactive waste. Industrial ecology and recycling industry. Environmental Biotechnology – Scope and applications; Concept of cleaner technology.

Unit –V Credit hours: 12

Ecology of Disturbed Ecosystems; Wastelands – Description, classification. Disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems; Environmental impacts of mining and industrialization. Restoration: Aims and strategies of restoration; physical, chemical, biological and biotechnological tools of restoration.Phytoremediation of disturbed ecosystems; Acceleration of ecological succession, reintroduction of biota.

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.
12. Aery N.C. 2010. Manual of Environmental Analysis. Ane Books. New Delhi.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M. Sc. BOTANY SEMESTER –IV (2016-17)

Discipline Specific Electives

M4BOT03-ET03D

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

Skill Enhancement Course Elective

BOT-SP01A
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

Skill Enhancement Course Elective

BOT-SP02A
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.

Skill Enhancement Course Elective

BOT-SP03A
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.

Skill Enhancement Course Elective

BOT-SP04A

Nursery, Gardening and 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.

Skill Enhancement Course Elective
BOT-SP05A
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.

Skill Enhancement Course Elective

BOT-SP06A

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.

Skill Enhancement Course Elective

BOT-SP07A
Commercialization of Micropropagation Technologies

Unit-I Credit hours: 6

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: 6

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: 6

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: 6

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: 6

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