Mohanlal Sukhadia University
Udaipur, Rajasthan, India

Department of Botany

Syllabus

M.Sc. Botany- NEP 2020

Department of Botany
Mohanlal Sukhadia University, Udaipur (Rajasthan)

PROGRAM OUTCOMES FOR M.Sc. BOTANY

Plant sciences is now an amalgamation of basic and applied science. Plants besides being the unique capability of plants to trap solar energy and provide food to all cannot be replicated by any system. Conventional studies like plant identification is now being supplemented with molecular techniques like DNA Barcoding. The courses have been designed to benefit all Botany students to study various aspects of plant science including its practical applications. Keeping in mind that these students can take up teaching at different levels, research work in research institutes and or industry, doctoral work, environment impact assessment, biodiversity studies, entrepreneurship, scientific writing relevant topics have been included in the curriculum. Students would be benefited with knowledge of core subjects like plant diversity, physiology and biochemistry, molecular cytogenetics and application of statistics etc. which are offered in these subjects modules on analytical techniques, plant tissue culture and phytochemistry would make them obtain skills in doing research. All the courses in the programme are carefully designed to equip the students for competitive exams like CSIR NET, SET etc. and to write research proposals for grants.

PO1	Understanding the classification of plants from cryptogams to Spermatophyte. Identification of the flora in field. Study of biodiversity in relation to habitat correlate with climate change, land and forest degradation. Application of Botany in agriculture through study of plant pathology. Palaeobotany to trace the evolution of plants.
PO2	Understand the ultrastructure and function of cell membranes, cell communications, signaling, genetics, anatomy, taxonomy, ecology and plant physiology and biochemistry.
PO3	Molecular and Physiological adaptations in plants in response to biotic and abiotic stress. Genes responsible for stress tolerance genetic engineering of plants
PO4	To understand the multi functionality of plant cells in production of fine chemicals. There wide spread industrial applications.

Overall development

After completion of this course, it will educate students about plant science and inculcate strong fundamentals on modern and classical aspects of Botany, build life skills in Edible mushroom cultivation, Biofertilizer production, Greenhouse maintenance and Seed technology through value-added courses and create platform for higher studies in Botany and facilitate students to take-up successful career in Botany.Maintain a high level of scientific excellence in botanical research with specific emphasis on the role of plants. Create, select and apply appropriate techniques, resources and modern technology in multidisciplinary way. Practice of subject with knowledge to design experiments, analyse and interpret data to reach to an effective conclusion.

They would identify, formulate and analyse the complex problems with reaching a substantiated conclusion. Logical thinking with application of biological, physical and chemical sciences. Learning that develops analytical and integrative problem-solving approaches. Best problem-solving skills in students would encourage them to carry out innovative research projects thereby making them to use knowledge creation in depth.

Structural Framework of the Two Years Post Graduate Programme

Table 3: Structural framework of the two years M.A./M.Com./M.Sc. Program under NEP2020					
	SEM-1	SEM-II	PG Diploma	SEM-III	SEM-IV
Core Courses	DCC-1-Th (4 Cr) DCC-2 Th (4 Cr) DCC-3 Th (4 Cr) DCC-4 Th (4 Cr) DCC-1 Th/Lab (4 Cr) DCC-2 Th/Lab (4 Cr)	DCC-5-Th (4 Cr) DCC-6 Th (4 Cr) DCC-7 Th (4 Cr) DCC-3 Th//Lab (4 Cr) DCC-4 Th/Lab (4 Cr)	Student who opt to exit after completion of the I year securing 48 credits will be awarded a PG Diploma in the relevant subject.	DCC-8-Th (4 Cr) DCC-9 Th (4 Cr)	DCC-10-Th (4 Cr)
Discipline Specific Elective/ Generic Elective Courses	-	GEC-(1-4) Th (4 Cr)		DSE-(5-8) Th (4 Cr) DSE-(9-12) Th (4 Cr) DSE-(1-4) Th/Lab (4 Cr) GEC-(5-8) Th/Lab (4 Cr)	DSE-(13-16) Th (4 Cr) DSE-(17-20) Th (4 Cr) DSE-(21-24) Th (4 Cr) DSE-(9-12) Th/Lab (4 Cr) DSE-(13-16) Th/Lab (4 Cr)
	24+0=24	20+4=24		8+16=24	4+20=24
	56(DCC)+40(DSE/GEC)=96				

1. **Discipline Specific Elective (DSE):**In this table four electives are proposed for a given DSE/GEC course (in the parentheses note the 4 options of each elective i.e., 1-4, or 5-8 or 13-16 etc). Currently, at least two i.e., the first two are to be proposed in each of the ten DSE/GEC courses. Two additional numbers are reserved for two more electives which may be proposed in future.
2. A DSE course opted by a student from his/her parent Department, will be the DSE for him/her. Else the course will be the GEC.
3. A student can opt 2-3 GEC which are under the DSE courses of other faculty.
4. Wherever there are only theory papers the courses can be of either 6 or 4 credits only. . In case of 6 credit for each course the number of courses given in above table will reduce accordingly.
5. In some of the disciplines it can be (2L+2P+2T) or (2L+4P).

Course Structure

NEP based CBCS Scheme of Syllabus for M.Sc. Botany

Level	Sem	Course type	Course code	Title of the Course	Delivery Type			Total Hours	No. of credits	External exam	Internal assessment	Total
SEMESTER I												
8	I	DCC	BOT8000T	BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES	L	T	-	60	4	80	20	100
			BOT8001T	MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY	L	T	-	60	4	80	20	100
			BOT8002T	PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY	L	T	-	60	4	80	20	100
			BOT8003T	CELL AND MOLECULAR BIOLOGY	L	T		60	4	80	20	100
			BOT8004P	BOT LAB I	-	-	P	120	4	80	20	100
			BOT8005P	BOT LAB II	-	-	P	120	4	80	20	100
										480	120	600
SEMESTER II												
8	II	DCC	BOT8006T	CYTOGENETICS, GENETICS AND PLANT BREEDING	L	T	-	60	4	80	20	100
			BOT8007T	PLANT DEVELOPMENTAL BIOLOGY AND RESOURCE UTILIZATION	L	T	-	60	4	80	20	100
			BOT8008T	PLANT GROWTH AND DEVELOPMENT	L	T	-	60	4	80	20	100
			BOT8009P	BOT LAB III	-	-	P	120	4	80	20	100
			BOT8010P	BOT LAB IV			P	120	4	80	20	100
		GEC	Given in list	From GEC Theory List- 1	L	T	-	60	4	80	20	100
										480	120	600

SEMESTER III												
9	III	DCC	BOT9011T	PLANT BIOCHEMISTRY AND PHYSIOLOGY	L	T	-	60	4	80	20	100
			BOT9012T	PLANT SYSTEMATICS	L	T	-	60	4	80	20	100
		DSE	Given in list	From DSE-List 1	L	T	-	60	4	80	20	100
			Given in list	From DSE-List 2	L	T	-	60	4	80	20	100
			Given in list	From DSE Lab list	-	-	P	120	4	80	20	100
		GEC	Given in list	From GEC Theory List-2	L	T	-	60	4	80	20	100
										480	120	600
SEMESTER IV												
9	IV	DCC	BOT9013T	PLANT TISSUE CULTURE AND GENETIC ENGINEERING	L	T	-	60	4	80	20	100
		DSE	Given in list	From DSE- List 3	L	T	-	60	4	80	20	100
			Given in list	From DSE- List 4	L	T	-	60	4	80	20	100
			Given in list	From DSE- List 5	L	T	-	60	4	80	20	100
			Given in list	From DSE Lab list			P	120	4	80	20	100
			BOT9127S	DSE Lab -RESEARCH ORIENTATION IN PLANT SCIENCES	-	-	P	120	4	80	20	100
										480	120	600

GEC Theory List- 1

SEMESTER II

Course Code	Title of the Course
BOT8100T	PLANT ECOLOGY, CONSERVATION AND EVOLUTION
BOT8101T	TOOLS AND TECHNIQUES IN PLANT SCIENCES

Discipline Specific Electives

DSE Theory List-1 (SEMESTER III)

Course Code	Title of the Course
BOT9100T	PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY
BOT9101T	PRINCIPLES OF PATHOLOGY AND PLANT DISEASES

DSE Theory List-2 (SEMESTER III)

Course Code	Title of the Course
BOT9102T	PRINCIPLES OF MICROBIAL TECHNOLOGY
BOT9103T	APPLIED PLANT SCIENCES
BOT9104T	BIOSYSTEMATICS-1

DSE Lab (SEMESTER III)

Note: Select any one from the following DSE Lab list, as per the selected DSE theory papers (List-1 & List 2)

Course Code	Title of the Course
BOT9105P	PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY, PRINCIPLES OF MICROBIAL TECHNOLOGY
BOT9106P	PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY, APPLIED PLANT SCIENCES
BOT9107P	PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY, BIOSYSTEMATICS-1
BOT9108P	PRINCIPLES OF PATHOLOGY AND PLANT DISEASES, PRINCIPLES OF MICROBIAL TECHNOLOGY
BOT9109P	PRINCIPLES OF PATHOLOGY AND PLANT DISEASES, APPLIED PLANT SCIENCES
BOT9110P	PRINCIPLES OF PATHOLOGY AND PLANT DISEASES, BIOSYSTEMATICS-1

GEC Theory List- 2 (SEMESTER III)

Course Code	Title of the Course
BOT9111T	Restoration Ecology
BOT9112T	Conservation Biology

DSE Theory List-3
(SEMESTER IV)

Course Code	Title of the Course
BOT9113T	SECONDARY METABOLITES AND BIOPROCESS ENGINEERING
BOT9114T	MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT

DSE Theory List-4
(SEMESTER IV)

Course Code	Title of the Course
BOT9115T	APPLICATIONS OF MICROBIAL TECHNOLOGY
BOT9116T	BIOSYSTEMATICS-1I

DSE Theory List-5
(SEMESTER IV)

Course Code	Title of the Course
BOT9117T	APPLIED PHYCOLOGY
BOT9118T	COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES

DSE Lab (SEMESTER IV)

Note: Select any one from the following DSE Lab list, as per the selected DSE theory papers (List-3, List 4 & List 5)

Course Code	Title of the Course
BOT9119P	SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, APPLICATIONS OF MICROBIAL TECHNOLOGY, APPLIED PHYCOLOGY
BOT9120P	SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, APPLICATIONS OF MICROBIAL TECHNOLOGY, COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES
BOT9121P	SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, BIOSYSTEMATICS-1I, APPLIED PHYCOLOGY
BOT9122P	SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, BIOSYSTEMATICS-1I, COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES
BOT9123P	MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, APPLICATIONS OF MICROBIAL TECHNOLOGY, APPLIED PHYCOLOGY
BOT9124P	MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, APPLICATIONS OF MICROBIAL TECHNOLOGY, COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES
BOT9125P	MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, BIOSYSTEMATICS-1I, APPLIED PHYCOLOGY
BOT9126P	MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, BIOSYSTEMATICS-1I, COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES

DSE LAB-Research Orientation in Plant Sciences (SEMESTER IV)

Code	Description
BOT9127S	**Research Orientation in Plant Sciences:** Credit hours for Research Orientation in Plant Sciences and marking schemes is equivalent to other DSEs. Students have to submit a hardcopy of dissertation and give a presentation of Research Orientation in Plant Sciences for evaluation. Details of dissertation proforma and marking scheme is enclosed as Annexure I.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – I

Code of the course	**BOT8000T**
Title of the course	**BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide fundamental and advance knowledge about the biology and biodiversity of various algae and bryophytes

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Learn criteria of classification, diversity, life form, reproduction, phylogeny, nutritional and economic importance of the plants.

CO2: Develop critical understanding on morphology, anatomy and reproduction.

CO3: Develop proficiency in the experimental technique and methods of appropriate analysis of plant of these groups.

CO4: Explore many unexplored plants for the economic benefits of human like medicine, biofertilizers and other uses because Rajasthan have diversified climatic condition.

CO5: Understand plant origin, evolution and their transition to land habitat because algae and bryophytes are one of the basics of botany.

Syllabus

Unit-I Lecture hours: 12

Algae: General account, thallus organisation, cell structure, reproduction, life cycle pattern, trends of classification. Systematic position of Blue Green Algae. Economic and evolutionary importance of algae.

Unit-II Lecture hours: 12

Algae: Salient features, interrelationships and comparative account of Chlorophyta, Charophyta, Xanthophyta and Bacillariophyta.

Unit –III Lecture hours: 12

Algae: Salient features, interrelationships and comparative account of Phaeophyta, Rhodophyta, Prochlorophyceae, Glaucophyceae, Eustigmatophyceae.

Unit-IV Lecture hours: 12

Bryophytes:. General characters and classification. Origin, evolution of gametophyte and sporophyte. Economic, evolutionary and ecological importance of bryophytes.

Unit-V Lecture hours: 12

Bryophytes: Comparative study of structure, reproduction and life cycle and interrelationship with special reference to Sphaerocarpales, Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales, Bryales.

Suggested Books and References:

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. Chandrakant, Pathak (2003). Bryophyta, Dominant Publishers and Distributors, New Delhi.
10. Parihar N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
11. Puri P. 1980. Bryophytes. Atma Ram and Sons, Delhi.
12. Rashid A (1998). An introduction to Bryophyta. Vikas Publishing House Pvt. Ltd, New Delhi.

Suggested E-resources

- https://www.algaebase.org/
- https://www.e-algae.org/
- https://ag.arizona.edu/azaqua/algaeclass/algaeweb.html
- https://stri.si.edu/story/bryophytes
- https://www.britishbryologicalsociety.org.uk/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – I

Code of the course	**BOT8001T**
Title of the course	**MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide fundamental and advance knowledge about the microbiology, mycology and plant pathology.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the general characteristic of archaebacteria and eubacteria

CO2: Develop a good knowledge of characteristics of different microorganisms and their significance.

CO3: Understand common characteristics of different classes of fungi with their economic and ecological importance.

CO4: Identify plant diseases ant their control measures.

CO5: Develop skill to perform basic experiments to grow and study vegetative and reproductive structure of microorganism in laboratory.

Syllabus

Unit –I Lecture 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 Lecture 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, spiroplasma and prions: A general account, economic and evolutionary importance.

Unit –III Lecture hours: 12

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.

Fungal associations: Mycorrhizae and Lichens; General account of morphology, reproduction, life cycle and significance.

Unit –IV Lecture hours: 12

Fungi: General account of morphology, reproduction, life cycle and economic importance of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Fungiimperfecti. Economic importance of fungi. Heterothallism, Heterokaryosis and Parasexuality in fungi.

Unit –V Lecture 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.

Suggested Books and References:

1. Alexopoulus, C. J., Mims, C. W. and Blackwel, M., Introductory Mycology, John Wiley & Sons Inc.
2. Mandahar, C. L. Introduction to Plant Viruses. Chand & Co. Ltd., Delhi.
3. Mehrotra, R. S. and Aneja, R. S. An Introduction to Mycology. New Age Intermediate Press.
4. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007
5. Textbook of Microbiology; Kanika Sharma. Ane books. New Delhi. 2011.

Suggested E-resources

- https://plpa.cfans.umn.edu/
- https://www.springer.com/journal/42161
- https://www.ffungi.org/
- https://www.mycobank.org/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – I

Code of the course	**BOT8002T**
Title of the course	**PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide fundamental and advance knowledge about the Pteridophytes, Gymnosperms and Palaeobotany

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand about the evolution of stellar system and heterospory.
CO2: Gain knowledge about the general character and classification of pteridophytes.
CO3: Understand about the general character of gymnosperms.
CO4: Learn about evolutionary relationship of Cycadopsida, Coniferopsida, Gnetopsida, Coniferales
CO5: Understand about the basic principle of paleobotany and know about prominent scientist.

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture 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-III Lecture hours: 12

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-IV Lecture 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.

Unit-V Lecture hours: 12

Palaeobotany: Geological time scale, types and nomenclature of fossils, fossilization, methods of study of fossils. Study of fossil archegoniates. Brief account of contributions of Eminent Scientists, Major National and International Institutions and recent advances.

Suggested Books and References:

1. Bhatnagar S.P and Moitra Alok 1996. Gymnosperms. New Age International Pvt. Ltd.Publishers, New Delhi, 470 pp.
2. Bierhorst D.W. 1971. Morphology of Vascular Plants. New York and London.
3. Biswas C and Johari B.M 2004. The Gymnosperms Narosa Publishing House, New Delhi.497 pp.

4. Parihar N.S. 1996. Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
5. Stewart W.N. and Rathwell G.W. 1993. Paleobotany and the Evolution of Plants. Cambridge University Press. Cambridge.

Suggested E-resources

- https://www.worldfloraonline.org/taxon/wfo-9949999998
- https://www.rbge.org.uk/science-and-conservation/herbarium/our-collections/gymnosperms/
- http://www.theplantlist.org/browse/G/
- https://www.pteridoportal.org/portal/index.php

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – I

Code of the course	**BOT8003T**
Title of the course	**CELL AND MOLECULAR BIOLOGY**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide fundamental and advance knowledge about the cell biology and molecular biology of the plants.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the structure and function of cell organelle at ultrastructure level
CO2: Explore molecular level regulation of cell cycle and cancer.
CO3: Understand the nucleic acid structure, replication and transcription mechanism
CO4: Develop the knowledge of functioning of protein synthesis machinery
CO5: Learn the gene regulation mechanism and basic techniques of genomics and proteomics

Syllabus

Unit-I Lecture hours: 12

Cell: Cell types and structure. Development of intracellular compartment, 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. Genome organization. Organization, diversity, evolution and function of mitochondrial and chloroplast genome.

Unit-II Lecture hours: 12

Cell cycle: mitosis and meiosis. Cell cycle regulation, role of cyclins and cyclin-dependent kinases.
Cancer: Molecular genetics of Cancer: oncogenes, tumor suppressor genes, metastasis, therapeutic interventions of uncontrolled cell growth, apoptosis.

Unit-III Lecture hours: 12

DNA: DNA structure and types (A-, B-, Z-, DNA). DNA replication, enzymes of DNA replication,DNA repair mechanisms.
RNA: RNA synthesis and processing: Transcription factors and machinery, RNA polymerases, transcription initiation, elongation and termination, RNA processing: RNA editing, capping, polyadenylation, splicing, structure and function of different types of RNA, Reverse transcriptase.

Unit-IV Lecture hours: 12

Protein: Types, Properties, Structure, function, Cellular localization, Reverse turn.
Protein synthesis and processing: Genetic code, Ribosome, Translation: formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, translational proof-reading, translational inhibitors, post-translational modification of proteins. Signal hypothesis, protein sorting to mitochondria and chloroplasts. Ramchandran Plot. DNA-Protein interactions and Protein-protein interactions

Unit-V Lecture hours: 12

Gene regulation: Regulation of gene expression in pro- and eukaryotes, the control sequences (operator, promoter, terminator, attenuator, enhancer),Operon model - lac, trp, attenuation, role of chromatin in

regulating gene expression and gene silencing.

Genomics and Proteomics: Introduction to Structural, functional genomics. Microarrays, Brief account of Proteomics. 2-D electrophoresis of proteins Concept of Transcriptomics: RNAi and Gene Silencing, Metabolomics and Metagenomics.

Suggested Books and References:

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.

Suggested E-resources

- https://onlinelibrary.wiley.com/journal/10958355
- https://bmcmolcellbiol.biomedcentral.com/
- https://www.embl.org/
- https://www.mbi.ucla.edu/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – I

Code of the course	**BOT8004P**
Title of the course	**BOT LAB I**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide practical knowledge based on theory papers (BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES and MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY).

Course Learning Outcomes

After completion of this course, students will be able to

- Understand the internal and external structures algae and bryophytes
- Understand the structures various microorganisms
- Understand the structure and reproductive structures of fungi
- Understand the symptoms of various diseases in plants

Syllabus

Practicals:

1. Microscopicpreparationsandstudy of followingalgalmaterials:*Chlamydomonas, Volvox, Coleochaete, Hydrodictyon, Ulva, Cladophora, Pithophora, Oedogonium, Vaucheria, Chara, Ectocarpus, Sargassum, Batrachospermum*, *Polysiphonia*, Diatoms- Available genera.
2. Isolationand establishment of axenicalgalculture
3. Study of externalandinternalmorphologyandmicroscopicpreparations of followingBryophytes:*Marchantia, Plagiochasma, Asterella, Targionia, Pellia*, *Porella*, *Anthoceros, Notothylus, Sphagnum, Funaria, Rhodobryum*and*Polytrichum*.
4. Isolation culture and identification of bacteria from various sources.
5. Identification of cultured bacteria using Gram's stain.
6. Isolation culture and identification of blue green algae from various sources and study of heterocyst.
7. Study and identification of following fungal genera: *Synchytrium*, *Phytopthora*, *Peronospora*, *Mucor*, *Penicillium*, *Erysiphe*, *Claviceps*, *Agaricus*, *Puccinia*, *Uromyces*, *Melampsora*, *Sphacelotheca*.
8. Isolation and identification of mycorrhizae associated with various plant species.
9. Study of important plant diseases
10. Study of lichens/mycorrhiza
11. Local field trip

Any other experiment setup by the faculty covering the theme of the paper and learning outcomes may also be included.

Scheme of Examination

External examination- 80 Marks

- Major practical exercise (based on BOT8000T) – 16 Marks
- Minor practical exercise (based on BOT8000T) – 08 Marks
- Major practical exercise (based on BOT8001T) – 16 Marks
- Minor practical exercise (based on BOT8001T) – 08 Marks
- Identification and comments of spots – 12 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Chapman V.J and Chapman D.J (1973). The Algae. Macmillan and company, New York.
2. Fritsch F.E (1945). The Structure and Reproduction of the Algae Volume I and II, Cambridge University Press.
3. Kumar H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
4. Morries I. 1986. An Introduction to the Algae. Cambridge University Press, U.K.
5. Round F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.
6. Vijayraghavan M.R and Bela Bhatia (1997), Brown Algae: Structure, Ultrastructure and Reproduction, APH publishing Corporations, New Delhi.
6. Mandahar, C. L. Introduction to Plant Viruses. Chand & Co. Ltd., Delhi.
7. Mehrotra, R. S. and Aneja, R. S. An Introduction to Mycology. New Age Intermediate Press.
7. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007

Suggested E-resources

- https://www.algaebase.org/
- https://www.e-algae.org/
- https://ag.arizona.edu/azaqua/algaeclass/algaeweb.html
- https://stri.si.edu/story/bryophytes
- https://www.springer.com/journal/42161
- https://www.ffungi.org/
- https://www.mycobank.org/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – I

Code of the course	**BOT8005P**
Title of the course	**BOT LAB II**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide practical knowledge based on theory papers (PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY and CELL AND MOLECULAR BIOLOGY).

Course Learning Outcomes

After completion of this course, students will be able to

- Understand the internal and external structures pteridophytes
- Understand the internal and external structures gymnosperms
- Understand the structure of plant fossils
- Understand the cell division and structure of cell organelles
- Understand the molecular biology of plants and bioinformatics through various practicals

Syllabus

Practicals

1. Study of temporary, double stained microscopic preparations of Root/ stem/ rhizome/ petiole/ reproductiveparts of following pteridophytes:
2. *Psilotum, Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Osmunda, Lygodium, Gleichenia, Cyathea, Dryopteris, Pteris, Actiniopteris, Adiantum, Marsilea, SalviniaandAzolla*.
3. Permanent doublestainedmicroscopicpreparations 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*
4. T.S. Leaflet and Rachis of *Cycas*and*Zamia*andneedle of *Pinus*.
5. T.S. of coralloid root of *Cycas*.
6. Microscopic preparations of male cone of *Pinus*and male andfemalecones of *Ephedra*.
7. Study of male coneandmegasporophyll of *Cycas*.
8. Study of fossil slides and specimens.
9. General study of chromosomes: Mitosis: Onion, Meiosis: Onion.
10. Ultrastructure of cells, cell organelles (study through microphotographs)
11. Isolation of genomic DNA and its visualization on Agarose gel.
12. Quantification of DNA.
13. Cot-curve preparation for given DNA sample.
14. Demonstration of function of thermal cycler and thermal program
15. Demonstration of preparation of reaction mixture for amplification of gene of interest from isolated genomic DNA
16. Horizontal gel electrophoresis for separation of amplified PCR products for marker studies
17. Demonstration of primer designing for amplification of gene of interest
18. Perform BLAST for given nucleotide sequence
19. Sequence retrieval from databases.

Any other experiment setup by the faculty covering the theme of the paper and learning outcomes may also be included.

Scheme of Examination

External examination- 80 Marks

- Major practical exercise (based on BOT8002T) – 16 Marks
- Minor practical exercise (based on BOT8002T) – 08 Marks
- Major practical exercise (based on BOT8003T) – 16 Marks

- Minor practical exercise (based on BOT8003T) – 08 Marks
- Identification and comments of spots – 12 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Bierhorst D.W. 1971. Morphology of Vascular Plants. New York and London.
2. Biswas C and Johari B.M 2004. The Gymnosperms Narosa Publishing House, New Delhi.497 pp.
3. Parihar N.S. 1996. Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
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.

Suggested E-resources

- https://www.worldfloraonline.org/taxon/wfo-9949999998
- https://www.rbge.org.uk/science-and-conservation/herbarium/our-collections/gymnosperms/
- http://www.theplantlist.org/browse/G/
- https://onlinelibrary.wiley.com/journal/10958355
- https://bmcmolcellbiol.biomedcentral.com/
- https://www.embl.org/
- https://www.mbi.ucla.edu/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – II

Code of the course	**BOT8006T**
Title of the course	**CYTOGENETICS, GENETICS AND PLANT BREEDING**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance theoretical knowledge of Cytogenetics, Genetics and Plant Breeding

Course Learning Outcomes

After completion of this course, students will be able to

- **CO1:** To develop conceptual understanding of chromosomes, law of inheritance, genetic basis of loci, alleles and their linkage.
- **CO2:** Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders and study of chromosomal basis of inheritance.
- **CO3:** Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary level.
- **CO4:** Develop conceptual understanding of plant genetic resources, plant breeding, gene bank and gene pool.
- **CO5:** Learning the methods of crop improvement along with development of mapping population in plants, QTL mapping, and molecular marker assisted breeding.

Syllabus

Unit-I Lecture hours: 12

Chromosomes: Structure of chromatin and chromosomes, heterochromatin, euchromatin, Nucleosome structure, Karyotyping, DNA scaffolds and loops. Lampbrush and Polytene chromosomes, Supernumerary chromosomes, Structural and numerical alterations in chromosomes, C-value paradox, Cot curve and its significance, Unique and repetitive DNA, Gene families, transposable elements in eukaryotes and prokaryotes.

Unit-II Lecture hours: 12

Mendelismand Neo-Mendelism: Mendalian laws of inheritance, Modern concept of gene and alleles, Gene gene interactions, Multiple alleles and pleiotropy, pseudoalleles, complementation tests, lethal alleles, penetrance and expressivity.

Unit-III Lecture hours: 12

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

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

Unit-IV Lecture hours 12

Pedigree: Pedigree analysis, lod score for linkage testing, genetic disorders. Quantitative genetics: Polygenic inheritance.

Mutations: Spontaneous and induced mutations, physical and chemical mutagens. molecular basis of gene mutations,.

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

Unit-V Lecture 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.

Molecular plant breeding: Development of mapping population in plants, QTL mapping, Importance of molecular marker assisted breeding.

Suggested Books and References:

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

Suggested E-resources

- https://learn.genetics.utah.edu/
- https://medlineplus.gov/genetics/
- https://www.frontiersin.org/journals/genetics
- https://cals.ncsu.edu/horticultural-science/research/global-plant-breeding/
- https://www.fibl.org/en/themes/plant-breeding

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – II

Code of the course	**BOT8007T**
Title of the course	**PLANT DEVELOPMENTAL BIOLOGY AND RESOURCE UTILIZATION**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance theoretical knowledge of plant developmental biology and resource utilization

Course Learning Outcomes

After completion of this course, students will be able to

- **CO1:** Learn about the organization of meristem and vascular tissue differentiation
- **CO2:** Understand about the anatomical structure of stem and roots and learn the genetic and molecular aspects of flower development.
- **CO3:** Understand the structure of anther and pollen wall because ultrastructure of pollen grain plays an important role in taxonomy. Evaluate the special structures and types of male and female gametophyte and learn the reproductive process in angiospermic plants.
- **CO4:** Understand the mechanism of pollination and fertilization and can relate between embryo, endosperm and seed. Comprehend the causes of polyembryony and apomixis with its classification.
- **CO5:** Learn about the ethnobotanical practices and economic importance of plants. Increase an awareness and appreciation of plants and plant products encountered in everyday life of human use

Syllabus

Unit-I Lecture hours: 12

Meristems: Introduction, organization of meristems, shoot development– organization of the shoot apical meristems (SAM), Cytological and molecular analysis of SAM; Control of tissue differentiation, especially xylem and phloem, wood development in relation to environmental factors. Root development -Organization of root apical meristem (RAM), Vascular tissue differentiation, lateral roots; root hairs. Root-microbe interaction.

Unit –II Lecture hours: 12

Plant anatomy: Primary and secondary structure of root and stem of angiosperms. Anomalous secondary growth in stem and roots of angiosperms. Leaf anatomy. Leaf development and phyllotaxy.
Flower: Evolution of flower, genetics of floral organ differentiation; foliar stamens; open carpels; primitive living angiosperms, floral anatomy, inferior ovary, placentation and its evolution.

Unit –III Lecture hours: 12

Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen germination, pollen tube growth and guidance, pollen embryos.
Female gametophyte: Ovule development and types, placentation types and its evolution.
Megasporogenesis.
Embryo sacs: organization of the embryo sac, types of embryo sacs.

Unit –IV Lecture hours: 12

Pollination and Fertilization: pollen-pistil interaction; pollination mechanisms and vectors; sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspect).

Double fertilization, *in vitro* fertilization.

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 and significance). Apomixis.

Unit –V Lecture 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, dye plants, gum yielding plants, oil yielding plants fruits and nuts, vegetables, spices, condiments, beverages, medicinal plant, rubber yielding plants and petrocrops, Centres of origin.

Suggested Books and References:

- 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 (3rd 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.

Suggested E-resources

- https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/plant-development
- https://onlinecourses.nptel.ac.in/noc20_bt36/preview
- https://www.plantdev.wzw.tum.de/home.html
- https://plantae.org/
- https://www.kew.org/science/collections-and-resources/collections/economic-botany-collection
- https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/economic-botany

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – II

Code of the course	**BOT8008T**
Title of the course	**PLANT GROWTH AND DEVELOPMENT**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance theoretical knowledge of plant hormones, photoreceptors, signal transduction and morphogenesis in plants.

Course Learning Outcomes

CO1: Students will be able to understand the plant-water relationship and various mechanisms of active and passive transportation of molecules across the living membranes.

CO2: Students will be able to understand the importance of micro and macro-nutrients on plant growth and development. They will also understand the various factors controlling seed development and germination.

CO3: Students will be skilled theoretically about the biosynthesis and physiological effects of various plant growth regulators.

CO4: Students will learn about the importance of photoperiods and role of various photoreceptprs in flowering.

CO5: Students will learn various mechanisms of signal transduction in plants.

Syllabus

Unit-I Lecture 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 Lecture 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 Lecture 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 Lecture 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 Lecture 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.

Suggested Books and References:

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.

Suggested E-resources

- http://www.phytohormones.info/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4242202/
- https://organismalbio.biosci.gatech.edu/chemical-and-electrical-signals/plant-hormones-and-sensory-systems/
- https://study.com/academy/lesson/signal-transduction-in-plants-from-reception-to-response.html
- https://plantae.org/
- https://www.kew.org/science/collections-and-resources/collections/economic-botany-collection

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – II

Code of the course	**BOT8009P**
Title of the course	**BOT LAB III**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (CYTOGENETICS, GENETICS AND PLANT BREEDING, and PLANT DEVELOPMENTAL BIOLOGY AND RESOURCE UTILIZATION).

Course Learning Outcomes

CO1: Students will learn to perform various practicals of cytogenetics.
CO2: Students will learn to perform various practicals of genetics.
CO3: Students will learn to perform various practicals of plant breeding.
CO4: Students will learn to perform various practicals of plant developmental biology
CO5: Students will understand the practical aspects of economic botany.

Scheme of Examination

External examination- 80 Marks

- Major practical exercise (based on BOT8006T) – 16 Marks
- Minor practical exercise (based on BOT8006T) – 08 Marks
- Major practical exercise (based on BOT8007T) – 16 Marks
- Minor practical exercise (based on BOT8007T) – 08 Marks
- Identification and comments of spots – 12 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Syllabus

Practicals

1. Meiotic irregularity in *Rhoeo discolor*.
2. Study of Salivary gland chromosome in *Chironomas*.
3. Emasculation, crossing and bagging in crop plants.
4. Problem of genetics.
5. Karyotype determination in onion.
6. Barr body analysis.
7. Pedigree analysis.
8. Genetic exercises and test of goodness of fit using Chi-square
9. Training in paraffin wax method for preparation of serial sections from fixation to mounting of permanent slides
10. Staining of slides using single and double stains
11. Demonstration of slides showing embryological peculiarities (male and female gametophytes, endosperm, embryo)
12. Anatomical study of the following materials:

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

    Floralanatomy: Buds of *Opuntia, Rosa, Calotropis, Hibiscus*and*Nerium*.
    NodalAnatomy: *Calotropis, Nerium*

13. Knowledge of at least 25 plant species of economically and traditionally important plants.

Any other experiment setup by the faculty covering the theme of the paper and learning outcomes may also be included.

Suggested Books and References:

- Burnham C. R. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
- Hartl D. L. and Jones E. W. Genetics: Principles and Analysis Jones and Barew Publishers Massachusetts USA.
- Karp G. 2015. Cell and Molecular Biology : Concepts and Experiments, John Wiley and Sons Inc USA.
- Fahn, A. 1982. Plant Anatomy (3rd Ed.), Pergamon Press, Oxford.
- Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. Comparative Embryology of Angiosperms, Vol. I & II, SpringerVerlag.
- Biochemistry & Molecular Biology of Plants; Eds: Bob Buchanan, Wilhelm Gruissem, Russell Jones (Editor) Wiley; 1st. edition. 2002.
- Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants. M. N. V. Prasad, Kazimierz Strzalka, M. N. V. Prasad. Springer. 2002.

Suggested E-resources

- https://web.mnstate.edu/chastain/assets/pp-lab-manual-2012.pdf
- https://www.rlbcau.ac.in/pdf/Forestry/FBT-111%20%20Plant%20Physiology.pdf
- https://www.biologydiscussion.com/plant-physiology-2/experiments-plant-physiology-2/top-45-experiments-on-plant-physiology/34628
- https://medlineplus.gov/genetics/
- https://www.frontiersin.org/journals/genetics
- https://www.fibl.org/en/themes/plant-breeding

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – II

Code of the course	**BOT8010P**
Title of the course	**BOT LAB IV**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (Plant Growth and Develppmwnt)

Course Learning Outcomes

CO1: Students will learn to perform practical to evaluate the effects of radiation on seed germination.
CO2: Students will learn to perform seed viability test,
CO3: Students will understand the effects of ABA on stomata opening and closing.
CO4: Students will learn to perform the effect of IAA on rooting.
CO5: Students will understand the effect of various hormones on seed germination and senescence.

Syllabus

Practicals

1. Study the effects of radiation on seed germination.
2. Seed viability test.
3. Study the the effects of ABA on stomata opening and closing.
4. Study the effect of IAA on rooting.
5. Study the effect of various hormones on seed germination and senescence.

Any other experiment setup by the faculty covering the theme of the paper and learning outcomes may also be included.

Scheme of Examination

External examination- 80 Marks

- Major practical exercise (based on BOT8008T) – 24 Marks
- Minor practical exercise (based on BOT8008T) – 10 Marks
- Minor practical exercise (based on BOT8008T) – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Biochemistry & Molecular Biology of Plants; Eds: Bob Buchanan, Wilhelm Gruissem, Russell Jones (Editor) Wiley; 1st. edition. 2002.
2. Introductory Plant Physiology, 2nd Edition G. Ray Noggle (Emeritus),George J. Fritz. Prentice Hall of India. 2002.
3. Plant Physiology; Sebanek J. Sebanek. Elsevier Science & Technology. 1992.
4. 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.
5. Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants. M. N. V. Prasad, Kazimierz Strzalka, M. N. V. Prasad. Springer. 2002.

Suggested E-resources

- http://www.phytohormones.info/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4242202/
- https://study.com/academy/lesson/signal-transduction-in-plants-from-reception-to-response.html
- https://plantae.org/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – II

Code of the course	**BOT8100T**
Title of the course	PLANT ECOLOGY, CONSERVATION AND EVOLUTION
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	GEC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance theoretical knowledge of ecosystem, ecology, conservation of threatened plants and plant evolutionary biology.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the concept of population ecology and population genetics.
CO2: Learn about community structure and interaction**.**
CO3: Have knowledge of ecosystem functioning and global pollution phenomenon.
CO4: Understand concept of biodiversity and conservation strategies.
CO5: Conceptualize the phenomenon of evolution and speciation.

Syllabus

Unit-I Lecture hours: 12

Population: Concept of Metapopulation, Properties of populations (birth rate, death rate, age pyramids, survivorship curves, logistic model, carrying capacity), r- and k- strategies, life history pattern, Concept of Population Genetics (Hardy–Weinberg principle), Concept of Niche and Habitat; types of niche, niche width and overlap, character displacement, Homeostasis.

Unit-II Lecture hours: 12

Community Ecology: Biological and physical structure, Raunkiaer's Life form, organismal and individualistic model of community, Edges and ecotones, Succession; Concept, models and mechanisms.

Community interaction: Intraspecific population regulation, interspecific competition models; Lotka-Volterra model, type of interactions.

Unit-III Lecture hours: 12

Ecosystem: Ecosystem **s**tructure and function, Ecosystem stability; concept of resistance and resilience, Ecological energetic; energy flow through ecosystem. Global biogeochemical cycles of C, N, P and S.

Pollution: Global environmental changes; green house gases, O_3 depletion, eutrophication, International protocols and Acts related with environmental awareness and conservation, carbon foot print, carbon credits, carbon sequestration, Phytoremediation, Plant indicator.

Unit-IV Lecture hours: 12

Plant Biodiversity: Concept of Biodiversity, types of biodiversity, measurement of biodiversity (Simpson and Shannon diversity index), IUCN categories of threat. Strategies for conservation – *In situ* (Concept of Hotspots, Sanctuaries, National parks, Biosphere reserves) and *Ex situ* (Seed bank, gene bank, botanical garden, in vitro etc.). Important conservation projects in India. International efforts and peoples participation for conservation. Important terms like Key stone species, Umbrella species, and flagship species, rivet popper hypothesis.

Unit-V Lecture hours: 12

Evolution: 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. Natural selection and Genetic Drift, concepts of neutral evolution. The Mechanisms of evolution, Speciation; allopatricity and sympatricity; convergent and divergent evolution.

Suggested Books and References:

- Aery, N.C. 2010. Manual of Environmental Analysis, Ane Books Pvt. Ltd., New Delhi.
- Kormondy, E.J. 1996. Concepts of Ecology. PrenticeHall India Pvt.Ltd., 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.
- 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.
- Swaminathan, M.N. & Jain, R.S. Biodiversity: Implications for global security, Macmillan, India. 1982.

Suggested E-resources

- https://www.iucn.org/
- https://www.unep.org/
- https://www.plant-ecology.info/
- https://ecology.uni-hohenheim.de/en/110619
- https://vtputkal.odisha.gov.in/subjectwise/plant-ecology-and-phytogeography/
- https://sustainability-innovation.asu.edu/ecologyexplorers/teacher-toolbox/lesson-plans/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
MSc Botany
Semester – II

Code of the course	**BOT8101T**
Title of the course	**TOOLS AND TECHNIQUES IN PLANT SCIENCES**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	GEC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance theoretical knowledge the various tools and techniques used in plant biology research.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the basic principle of microscopy, centrifugation and electrophoresis
CO2: Explore chromatography and spectrophotometry techniques.
CO3: Understand the basic principle of bioinformatics.
CO4: Develop the knowledge of central tendency and dispersion.
CO5: Learn the application of correlation, regression and analysis of variance.

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture 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 Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

Suggested Books and References:

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

Suggested E-resources

- https://www.ausetute.com.au/chromato.html
- https://zeiss-campus.magnet.fsu.edu/articles/basics/index.html
- https://www.embl.org/
- https://www.ncbi.nlm.nih.gov/
- https://www.hsph.harvard.edu/wp-content/uploads/sites/565/2019/09/HST190_Lecture_1.pdf

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9011T**
Title of the course	**PLANT BIOCHEMISTRY AND PHYSIOLOGY**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20= 60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed and prepared to provide fundamental and advance knowledge of various biochemical and physiological processes in plants.

Course Learning Outcomes

After the completion of the course the students will be able to:

CO1: Students will be able to understand the principles of the thermodynamics. They will also learn about the classification, structure and functions of various biomolecules.

CO2: Students will understand the mode of action of enzymes in detail. They will also understand the mechanism of nitrogen fixation in detail.

CO3: Students will be skilled theoretically about the mechanism of photosynthesis in C3, C4 and CAM plants.

CO4: Students will understand the various pathways of respiration and the mechanism of ATP biosynthesis in mitochondria.

CO5: Students will study the plant responses to various biotic and abiotic stresses.

Syllabus

Unit-I Lecture hours: 12

Bioenergetics: Principles of the thermodynamics, Gibb's free energy and chemical potential, redox potential. Types of Phosphorylations.

Carbohydrates: Classification, structure, properties.

Fats and Lipids: Fatty acids and fatty oils, Structure and function of lipids, classification of lipids.

Amino acids: Structure, Types, Properties, Functions.

Secondary metabolites: A brief account.

Unit-II Lecture hours: 12

Enzymes: General characters, nomenclature and classification, Mode of enzyme action, Michaelis – Menton equation and its significance. Regulation of enzymes, allosteric modulation, enzyme inhibition, coenzymes, isoenzymes, abzymes. Factors effecting enzyme activity.

Biological nitrogen fixation: Non symbiotic and Symbiotic, nitrification and denitrification. Role and structure of Nitrogenase, Leghemoglobin, Genetics of Nitrogen fixation. Mechanism of nitrogen fixation.

Unit-III Lecture hours: 12

Photosynthesis: Historical account, Evolution of photosynthetic apparatus, 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-IV Lecture hours: 12

Respiration: Over view, Historical account, Evolution of anaerobic and aerobic metabolism, Aerobic respiration: glycolysis and its regulation, TCA cycle and its regulation, Pentose phosphate pathway, Oxidative electron transport and chemiosmotic hypothesis of ATP synthesis, alternative

oxidase system, Anaerobic respiration. Gluconeogenesis

Unit-V Lecture 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.

Suggested Books and References:

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. MadhavaRao, 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.

Suggested E-resources

- https://onlinecourses.swayam2.ac.in/cec21_bt03/preview
- https://annamalaiuniversity.ac.in/studport/download/agri/soilsci/resources/SAC%20124%20fundamentals%20of%20biochemistry%20lecture%20notes.pdf
- https://uou.ac.in/sites/default/files/slm/MSCBOT-601.pdf
- https://www.biologydiscussion.com/notes/plant-physiology-notes/lecture-notes-on-plant-physiology/34647
- https://www.sciencedirect.com/journal/plant-physiology-and-biochemistry
- https://www.sciencedirect.com/journal/journal-of-plant-physiology

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9012T**
Title of the course	**PLANT SYSTEMATICS**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed and prepared to provide in-depth knowledge about plant nomenclature, identification and classification.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the theory and practices of describing, naming, classifying and preparing herbarium of plants because such work is essential for understanding of biodiversity and its conservation including nomenclature, principles and evolutionary trends in taxonomy.

CO2: Assess terms and concepts related to taxonomy of plants and systems of classification and generalize the characters of the families according to various proposed systems of classification.

CO3: Learn about the various terminology used for description of flower characteristics and plant species

CO4: Understand the diagnostic features of various angiosperm families

CO5: Gain knowledge about role of various discipline in serving as evidence for taxonomic purpose.

Syllabus

Unit-I Lecture hours: 12

Fundamentals of Systematics: Historical account of development of Taxonomy, Plant nomenclature, Type concept, Melbourne code 2012, Taxonomic hierarchy -concept of taxa, species, genus, family

Unit-II Lecture 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 (APG).

Unit-III Lecture hours: 12

Taxonomic terminology; floral formula and floral diagram. Phylogeny; origin and evolution of angiosperms, numerical taxonomy, Botanical gardens, Herbarium,

Unit-IV Lecture hours: 12

Angiosperm families: Diagnostic features of Ranunculaceae, Asteraceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Poaceae, Combretaceae, Loranthaceae, Lemnaceae, Cyperaceae, Araceae and Orobanchaceae.

Unit-V Lecture hours: 12

Taxonomicevidence – Role of morphology, anatomy, embryology, palynology, phytochemistry and molecular systematics.

Suggested Books and References:

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., EIGazaly, 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.

Suggested E-resources

- https://open.lib.umn.edu/horticulture/chapter/2-1-plant-taxonomy/
- http://www.nbpgr.ernet.in/Downloadfile.aspx?EntryId=9115
- https://www.studocu.com/in/document/mahatma-gandhi-university/botany/plant-taxonomy-basics/32818304
- https://alec.unl.edu/documents/cde/2017/natural-resources/classification-and-naming-of-plants.pdf
- https://www.senecahs.org/pages/uploaded_files/Plant%20Classification.pdf

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9100T**
Title of the course	**PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed and prepared to provide advance knowledge about plant bioenergetics and biochemistry,

Course Learning Outcomes

After completion of this course, students will be able to

- **CO1:** Learn about the bioenergetics of photosynthesis
- **CO2:** Gain knowledge about various fluorescence parameters
- **CO3:** Understand metabolism related with carbohydrate and fatty acid
- **CO4:** Understand biosynthetic pathway of amino acids
- **CO5:** Learn about concept of stress physiology

Syllabus

Unit-1 Lecture hours: 12

Bioenergetics of Photosynthesis: Ultrastructure and functions of Photosystem I, Photosyntem II and F_1F_0ATP synthase; Oxygen evolving complex, Molecular mechanism of ATP biosynthesis, RuBisCO and PEP Carboxylase- structure and function; Regulation of photosynthesis in C3, C4 and CAM pathways.

Artificial Photosynthesis: solar fuels, hydrogen production.

Unit-II Lecture hours: 12

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

Unit-III Lecture hours: 12

Carbohydrate metabolism and regulation: Energetics of glycolysis, gluconeogenesis, regulation of glycolysis and gluconeogenesis, HMP shunt, Uronic acid pathway, Cori's cycle, Glyoxalate pathway.

Fatty acid metabolism and regulation: Biosynthesis of saturated & unsaturated fatty acids, Regulation of fatty acid metabolism, Alpha, Beta & Omega oxidation. Ketogenesis, Metabolism of triacylglycerols.

Unit-IV Lecture hours: 12

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

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

Unit-V Lecture hours: 12

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

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

Suggested Books and References:

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. MadhavaRao, 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.

Suggested E-resources

- https://ssec.si.edu/stemvisions-blog/what-photosynthesis
- https://www.nature.com/scitable/topicpage/photosynthetic-cells-14025371/
- https://www.mcgill.ca/sciedchantier7/resources/sample-lesson-plans/photosynthesis
- https://www.saps.org.uk/teaching-resources/resources/134/photosynthesis-a-survival-guide-for-teachers/
- https://ps.ueb.cas.cz/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9101T**
Title of the course	**PRINCIPLES OF PATHOLOGY AND PLANT DISEASES**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed and prepared to provide advance knowledge about various plant pathogens and symptoms of diseases in plants.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Apply the conceptual and the practical training to differentiate between a healthy and disease plant in field.

CO2: Isolation and Identification of plant pathogen.

CO3: To ascertain the cause of the disease by Koch's Postulates.

CO4: To Know the source, symptoms and etiology of diseases of major concern.

CO5: To know about disease forecasting

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours: 12

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

Unit –III Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

Suggested Books and References:

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.

Suggested E-resources

- https://link.springer.com/journal/10658
- http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf
- https://www.plantpathologyjournal.com/
- https://sites.google.com/a/uasd.in/ecourse/plant-pathology
- https://bsppjournals.onlinelibrary.wiley.com/journal/13643703
- https://www.annualreviews.org/content/journals/phyto

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9102T**
Title of the course	**PRINCIPLES OF MICROBIAL TECHNOLOGY**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed and prepared to provide advance knowledge of bioreactors and fermentation technology.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Learn about principles of fermentation technology, types of bioreactors and bioprocess parameters

CO2: Understand the overall fermentation process

CO3: Learn about strain selection and their improvement from the point of industry

CO4: Gain knowledge about the downstream processing

CO5: Develop the understanding of aerobic and anaerobic fermentation technology

Syllabus

Unit-I Lecture 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 Lecture hours: 12

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

Unit-III Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

Suggested Books and References:

1. Microbiology: Concepts and Applications; Michael Joseph Pelczar, E. C. S. Chan, Noel R. Krieg, McGraw-Hill Companies; 6th edition (February 1993).
2. General Microbiology; R.C. Dube and D. K. Maheswari. S Chand , New Delhi. 2000.

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

Suggested E-resources

- http://www.bbtech.sc.chula.ac.th/?page_id=3329
- https://simdos.unud.ac.id/uploads/file_pendidikan_dir/0f9c2f5da25bad8a90d28686665c8ff0.pdf
- https://www.sciencedirect.com/journal/enzyme-and-microbial-technology
- https://enviromicro-journals.onlinelibrary.wiley.com/journal/17517915
- https://link.springer.com/journal/12088

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9103T**
Title of the course	**APPLIED PLANT SCIENCES**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is prepared to provide various applications and techniques of plant biology in present scenario such as organic farming, biofertilizers, gardening practices etc.

Course Learning Outcomes

Overall, the paper has been designed to inculcate the basic and applied knowledge and skill enhancement with a view of entrepreneurship, self- employment and livelihood security among PG students of plant sciences. After completion of this course, students will be able to

CO1: To make the students aware about organic farming, biofertilizers and sustainable agriculture package and practices for productivity enhancement.

CO2: To learn different nursery and gardening techniques.

CO3: To get the knowledge and scope of landscape gardening and cultivation of flowers of commerce.

CO4: To make them aware about the pest and pathogens of plants of ornamental and floriculture value.

CO5: To get them aware about the Intellectual Property Rights, Copyrights and how to draw a patent for biological specimens/ processes, etc.

Syllabus

Unit-I Lecture 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 Lecture 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 Lecture 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 Lecture 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 Lecture 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).

Suggested Books and References:

1. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming AktaPrakashan, 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.

Suggested E-resources

- https://gardening.org/sustainable-gardening-practices/
- https://www.sciencedirect.com/journal/landscape-and-urban-planning
- https://www.usda.gov/peoples-garden/gardening-advice
- https://www.mdpi.com/2076-2607/10/6/1220
- https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2022.1002448/full
- https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm
- https://www.ipindia.gov.in/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9104T**
Title of the course	**BIOSYSTEMATICS-1**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the information about the principles of botanical nomenclature and classification of plants.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the basic principle of taxonomic classification.
CO2: Develop the knowledge of rules related with nomenclature.
CO3: Understand the basic principles of botanical nomenclature.
CO4: Gain the knowledge related with pioneer classification of plants.
CO5: Learn about the evolutionary history of angiosperms.

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours: 12

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

Unit-III Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

Suggested Books and References:

8. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming AktaPrakashan, Nadiad
9. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
10. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
11. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
12. Manjula Guru &*M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
13. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).

14. Nelson, P.U. 1991. Greenhouse operation and management. Prentice-Hall, NJ, USA.

Suggested E-resources

- https://www.tandfonline.com/journals/tweb20
- https://open.lib.umn.edu/horticulture/chapter/2-1-plant-taxonomy/
- https://libguides.bodleian.ox.ac.uk/plant_taxonomy
- http://www.nbpgr.ernet.in/Downloadfile.aspx?EntryId=9115
- https://www.studocu.com/in/document/mahatma-gandhi-university/botany/plant-taxonomy-basics/32818304
- https://alec.unl.edu/documents/cde/2017/natural-resources/classification-and-naming-of-plants.pdf
- https://www.senecahs.org/pages/uploaded_files/Plant%20Classification.pdf

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9105P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY and PRINCIPLES OF MICROBIAL TECHNOLOGY)

Course Learning Outcomes

CO1: Students will learn to about the stomatal physiology in C3, C4 and CAM plants.
CO2: Students will understand the basics of chlorophyll fluorescence analysis.
CO3: Students will learn techniques to quantify proline, total phenol chlorophyll contents and activities of antioxidant enzymes in plants.
CO4: Students will study the growth kinetics of bacteria and the effect of chemical factors on growth of production strain.
CO5: Students will learntechniques to isolate and purify microbial metabolites.

Syllabus

Practicals: Plant Bioenergetics and Applied Biochemistry

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

Practicals: Principles of Microbial Technology

1. Study of principle and working of important instruments used in industrial and bioprocess engineering.
2. Study of growth kinetics of bacteria.
3. Study of effect of physical factors on growth of production strain.
4. Study of effect of chemical factors on growth of production strain.
5. Study of effect of inoculum size on growth.
6. Study of effect of UV radiation on microbial growth.
7. Study of effect of chemical disinfectants on microbial growth.
8. Isolation and purification of microbial metabolites
9. Study of production of organic acids from bacterial strains.

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. S.S. Rajan, 2003 Practical Manual of Plant Ecology and Plant Physiology, Anmol Publications Pvt Ltd, New Delhi.
2. Kaufman, P.B., Labavitch, J., Anderson-Prouty, A. &Ghosheh, N.S. (1975) Laboratory Experiments in Plant Physiology. pp. 262+ ix.
3. N.K. Gupta, M.K. Sangha Manju Bala Sunita Gupta 2016 Practical In Plant Physiology and Biochemistry, Scientific Publishers (India).
4. Principles of Fermentation Technology; P F Stanbury , S. Hall , A. Whitaker. Butterworth-Heinemann; 2 edition. 1999.
5. Microbiology: an Introduction, G.J. Tortora. R.F. Burdell and C.L. Case. Benjamin-Cummings Publishing Company. 1989.
6. Experiments in Microbiology, Plant pathology and Biotechnology, K. R. Aneja. New Age international Publishers, 2004.

Suggested E-resources

- https://www.biologydiscussion.com/plant-physiology-2/experiments-plant-physiology-2/top-45-experiments-on-plant-physiology/34628
- https://biology4isc.weebly.com/plant-physiology-experiments.html
- https://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf
- https://uou.ac.in/sites/default/files/slm/MSCBOT-605(L).pdf
- https://ohioline.osu.edu/search/site/hyg%20fact%203000%20index
- https://www.youtube.com/watch?v=VzvIuhiPkc8
- https://coabhatapara.ac.in/downloads/PRACTICAL_MANUAL_OF_PLANT_PATHOLOGY.pdf

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9106P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY and APPLIED PLANT SCIENCES)

Course Learning Outcomes

CO1: Students will learn to about the stomatal physiology in C3, C4 and CAM plants.
CO2: Students will understand the basics of chlorophyll fluorescence analysis.
CO3: Students will learn techniques to quantify proline, total phenol chlorophyll contents and activities of antioxidant enzymes in plants.
CO4: Students will understand the mycorrhizal inoculation on plant growth.
CO5: Students will know about the root nodule development and the effects of Blue Green Algae on plant growth.

Syllabus

Practicals: Plant Bioenergetics and Applied Biochemistry

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

Practicals: Applied Plant Sciences

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 and their management.

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. S.S. Rajan, 2003 Practical Manual of Plant Ecology and Plant Physiology, Anmol Publications Pvt Ltd, New Delhi.
2. Kaufman, P.B., Labavitch, J., Anderson-Prouty, A. &Ghosheh, N.S. (1975) Laboratory Experiments in Plant Physiology. pp. 262+ ix.
3. N.K. Gupta, M.K. Sangha Manju Bala Sunita Gupta 2016 Practical In Plant Physiology and Biochemistry, Scientific Publishers (India).
4. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
5. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
6. Manjula Guru &*M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
7. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).

Suggested E-resources

- https://www.biologydiscussion.com/plant-physiology-2/experiments-plant-physiology-2/top-45-experiments-on-plant-physiology/34628
- https://biology4isc.weebly.com/plant-physiology-experiments.html
- https://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf
- https://www.ipindia.gov.in/
- https://gardening.org/sustainable-gardening-practices/
- https://www.sciencedirect.com/journal/landscape-and-urban-planning
- https://www.usda.gov/peoples-garden/gardening-advice
- https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9107P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (PLANT BIOENERGETICS AND APPLIED BIOCHEMISTRY and BIOSYSTEMATICS-1)

Course Learning Outcomes

CO1: Students will learn to about the stomatal physiology in C3, C4 and CAM plants.
CO2: Students will understand the basics of chlorophyll fluorescence analysis.
CO3: Students will learn techniques to quantify proline, total phenol chlorophyll contents and activities of antioxidant enzymes in plants.
CO4: Students will understand the about the identification of plants.
CO5: Students will know the locally available flora, the nomenclature of plants and classification exercise based on APG system.

Syllabus

Practicals: Plant Bioenergetics and Applied Biochemistry

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

Practicals: Biosystematics-I

1. Study of at least 10 locally available families of flowering plants.
2. Description and identification of plants of following families at genus and species levels using flora-
    - Basal angiosperms and Magnoliids: Nymphaeaceae, Magnoliaceae.
    - Basal Monocots:Araceae, Alistamaceae,
    - Petaloids monocots: Liliaceae, Smilaceae, Alliaceae and Orchidaceae.
3. Identification of plants at genus and species level of locally available wild and medicinal plants.
4. Classification exercise based on APG system.
5. Exercise based on nomenclatural citations to solve nomenclatural problems.

Field trips in and around Udaipur, compilation of field notes and preparation of herbarium sheets of 25 plants.

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. S.S. Rajan, 2003 Practical Manual of Plant Ecology and Plant Physiology, Anmol Publications Pvt Ltd, New Delhi.
2. Kaufman, P.B., Labavitch, J., Anderson-Prouty, A. &Ghosheh, N.S. (1975) Laboratory Experiments in Plant Physiology. pp. 262+ ix.
3. N.K. Gupta, M.K. Sangha Manju Bala Sunita Gupta 2016 Practical In Plant Physiology and Biochemistry, Scientific Publishers (India).
4. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2008). Plant Systematics- A Phylogenetic Approach. Sinaner Associates Inc, Massachusetts, USA.
5. Simpson, M.C. (2006). Plant Systematics. Elsevier, Amsterdam. 7. Stussy, T.F. 1990. Plant Taxonomy, Columbia University Press, USA.
4. Scott-Ram N.R.(1990). Tranformed Cladistics, Taxonomy and evolution. Cambridge University Press.

Suggested E-resources

- https://www.biologydiscussion.com/plant-physiology-2/experiments-plant-physiology-2/top-45-experiments-on-plant-physiology/34628
- https://biology4isc.weebly.com/plant-physiology-experiments.html
- https://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf
- https://open.lib.umn.edu/horticulture/chapter/2-1-plant-taxonomy/
- https://libguides.bodleian.ox.ac.uk/plant_taxonomy
- http://www.nbpgr.ernet.in/Downloadfile.aspx?EntryId=9115
- https://www.studocu.com/in/document/mahatma-gandhi-university/botany/plant-taxonomy-basics/32818304
- https://alec.unl.edu/documents/cde/2017/natural-resources/classification-and-naming-of-plants.pdf

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9108P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (PRINCIPLES OF PATHOLOGY AND PLANT DISEASES and PRINCIPLES OF MICROBIAL TECHNOLOGY)

Course Learning Outcomes

CO1: Students will learn to prepare culture media.
CO2: Students will measure spore size and Mycelium width.
CO3: Students will learn to identify plant pathogenic fungi and bacteria.
CO4: Students will learn techniques to isolate and purify microbial metabolites.
CO5: Students will practically understand the production of organic acids from bacterial strains.

Syllabus

Practicals: PRINCIPLES OF PATHOLOGY AND PLANT DISEASES

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

Practicals: PRINCIPLES OF MICROBIAL TECHNOLOGY

1. Study of principle and working of important instruments used in industrial and bioprocess engineering.
2. Study of growth kinetics of bacteria.
3. Study of effect of physical factors on growth of production strain.
4. Study of effect of chemical factors on growth of production strain.
5. Study of effect of inoculum size on growth.
6. Study of effect of UV radiation on microbial growth.
7. Study of effect of chemical disinfectants on microbial growth.
8. Isolation and purification of microbial metabolites
9. Study of production of organic acids from bacterial strains.

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

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. Plant Tumors, Arun Mishra, Today and Tomorrow's Printer and Publishers, India, 1985.
5. Plant Disease: An Advance Treatise, James G. Horsfall and Ellis B. Cowling, Second Edition, Academic Press, London, 1977
6. Microbiology: an Introduction, G.J. Tortora. R.F. Burdell and C.L. Case. Benjamin-Cummings Publishing Company. 1989.
7. Experiments in Microbiology, Plant pathology and Biotechnology, K. R. Aneja. New Age international Publishers, 2004.
8. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007.

Suggested E-resources

- https://ohioline.osu.edu/search/site/hyg%20fact%203000%20index
- https://www.youtube.com/watch?v=VzvIuhiPkc8
- https://coabhatapara.ac.in/downloads/PRACTICAL_MANUAL_OF_PLANT_PATHOLOGY.pdf
- https://phytopath.ca/education/experiments/
- https://www.youtube.com/watch?v=VzvIuhiPkc8
- https://phytopath.ca/education/experiments/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9109P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (PRINCIPLES OF PATHOLOGY AND PLANT DISEASES and APPLIED PLANT SCIENCES).

Course Learning Outcomes

CO1: Students will learn to prepare culture media.
CO2: Students will measure spore size and Mycelium width.
CO3: Students will learn to identify plant pathogenic fungi and bacteria.
CO4: Students will know about the root nodule development and the effects of Blue Green Algae on plant growth.
CO5: Students will know the practical knowledge of various IPR issues.

Syllabus

Practicals: PRINCIPLES OF PATHOLOGY AND PLANT DISEASES

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

Practicals: APPLIED PLANT SCIENCES

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 and their management.

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

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. Plant Tumors, Arun Mishra, Today and Tomorrow's Printer and Publishers, India, 1985.
5. Plant Disease: An Advance Treatise, James G. Horsfall and Ellis B. Cowling, Second Edition, Academic Press, London, 1977
6. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
7. Manjula Guru &*M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
8. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).

Suggested E-resources

- https://ohioline.osu.edu/search/site/hyg%20fact%203000%20index
- https://www.youtube.com/watch?v=VzvIuhiPkc8
- https://coabhatapara.ac.in/downloads/PRACTICAL_MANUAL_OF_PLANT_PATHOLOGY.pdf
- https://gardening.org/sustainable-gardening-practices/
- https://www.sciencedirect.com/journal/landscape-and-urban-planning
- https://www.usda.gov/peoples-garden/gardening-advice

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9110P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (PRINCIPLES OF PATHOLOGY AND PLANT DISEASES and BIOSYSTEMATICS-1).

Course Learning Outcomes

CO1: Students will learn to prepare culture media.
CO2: Students will measure spore size and Mycelium width.
CO3: Students will learn to identify plant pathogenic fungi and bacteria.
CO4: Students will understand the Classification exercise based on APG system.
CO5: Students will understand the nomenclature of plants.

Syllabus

Practicals: PRINCIPLES OF PATHOLOGY AND PLANT DISEASES

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

Practicals: BIOSYSTEMATICS-1

6. Study of at least 10 locally available families of flowering plants.
7. Description and identification of plants of following families at genus and species levels using flora-
    - Basal angiosperms and Magnoliids: Nymphaeaceae, Magnoliaceae.
    - Basal Monocots:Araceae, Alistamaceae,
    - Petaloids monocots: Liliaceae, Smilaceae, Alliaceae and Orchidaceae.
8. Identification of plants at genus and species level of locally available wild and medicinal plants.
9. Classification exercise based on APG system.
10. Exercise based on nomenclatural citations to solve nomenclatural problems.

Field trips in and around Udaipur, compilation of field notes and preparation of herbarium sheets of 25 plants.

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

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. Plant Tumors, Arun Mishra, Today and Tomorrow's Printer and Publishers, India, 1985.
5. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2008). Plant Systematics- A Phylogenetic Approach. Sinaner Associates Inc, Massachusetts, USA.
6. Simpson, M.C. (2006). Plant Systematics. Elsevier, Amsterdam. 7. Stussy, T.F. 1990. Plant Taxonomy, Columbia University Press, USA.
7. Scott-Ram N.R.(1990). Tranformed Cladistics, Taxonomy and evolution. Cambridge UniversityPress.

Suggested E-resources

- https://ohioline.osu.edu/search/site/hyg%20fact%203000%20index
- https://www.youtube.com/watch?v=VzvIuhiPkc8
- https://coabhatapara.ac.in/downloads/PRACTICAL_MANUAL_OF_PLANT_PATHOLOGY.pdf
- https://libguides.bodleian.ox.ac.uk/plant_taxonomy
- http://www.nbpgr.ernet.in/Downloadfile.aspx?EntryId=9115
- https://www.studocu.com/in/document/mahatma-gandhi-university/botany/plant-taxonomy-basics/32818304

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9111T**
Title of the course	**Restoration Ecology**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	GEC
Delivery Type of the Course	Lectures and tutorial (40+20= 60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the information about the ecosystem functioning and restoration of degraded ecosystem.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand about role of habitat in species conservation.
CO2: Gain knowledge about the ecosystem functioning in disturbed ecosystem.
CO3: Develop basic understanding of restoration ecology
CO4: Learn about the case studies of restoration of degraded ecosystem.
CO5: Understand about role of biotechnology in solving the environmental problems.

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours: 12

Managing exploitation: Human population growth and resource exploitation trends, determining sustainable yields through models, controlling exploitation.
Ecology of disturbed ecosystems: Disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems.

Unit-III Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

Suggested Books and References:

1. Singh, J.S., S.P & Gupta, S.R. 2006. Ecology, Environment and Resource conservation. Anamaya Publ., New Delhi, 688 pp.
2. Miller. G.T. 2004. Environmental Science. Thomson, California. 538 pgs.

3. Singh, J.S., Singh, S.P. & Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Company Pvt. Ltd., New Delhi. 929p.
4. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
5. Singh JS, Singh SP and Gupta SR (2014) Ecology, Environmental Science and Conservation. 4th Edition. S. Chand & Company Pvt. Ltd.

Suggested E-resources

- https://www.cbd.int/cb/E-learning
- https://www.cfainstitute.org/en/programs/learning-ecosystem
- https://study.com/academy/lesson/what-is-ecology-definition-lesson-quiz.html
- https://www.plt.org/educator-tips/top-ten-benefits-environmental-education/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – III

Code of the course	**BOT9112T**
Title of the course	**Conservation Biology**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	GEC
Delivery Type of the Course	Lectures and tutorial (40+20= 60hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the information about the conservation genetics, gene flow and molecular variance.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the population dynamics for conservation purpose
CO2: Learn about the life history pattern
CO3: Basic principles of conservation genetics
CO4: Gain knowledge about genetic differentiation, geneflow and molecular variance
CO5: Skilled about conservation genetics using study of some case studies

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours: 12

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

Unit-III Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

Suggested Books and References:

1 Beebee Trevor J. C., Rowe Graham 2008 An introduction to molecular ecology 2.ed.: Oxford : Oxford University Press, ISBN: 978-0-19-929205-9
2 Conservation Biology **(CB)** (1996) edited by I.F. Spellberg.
3 Biodiversity I **(B1)** (1988): understanding and protecting our biological resources. Edited by M. L. Reaka-Kudla, D. E. Wilson, and E. O. Wilson.
4 Biodiversity II **(B2)** (1997): understanding and protecting our biological resources. Edited by M. L. Reaka-Kudla, D. E. Wilson, and E. O. Wilson. (available online as an e-book at the university library).
5 Future of Life **(FL)** (2002) by E. O. Wilson.

6 JCAvise 2004. Molecular Markers, Natural History and Evolution. Sinauer Associates.
7 RDM Page and EC Holmes 1998. Molecular Evolution: A Phylogenetic Approach, Blackwell Science Ltd.
8 A Lowe, S Harris and P Ashton 2004. Ecological Genetics: Design, Analysis and Applications. Blackwell Publishing.

Suggested E-resources

- https://link.springer.com/journal/10592
- https://learn.genetics.utah.edu/content/science/conservation/
- https://www.nature.com/articles/nrg2844
- https://www.mdpi.com/journal/genes/special_issues/Conservation_Genetics_Genomics

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9013T**
Title of the course	**PLANT TISSUE CULTURE AND GENETIC ENGINEERING**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the in-depth knowledge about various tools and techniques used in *in vitro* propagation of plants and genetic engineering.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Students will be able to understand the hormonal regulation of morphogenesis *in vitro* in plants..

CO2: Students will understand the various techniques of protoplast isolation and somatic hybridization. They will also understand the development of variations in somatic cells during *in vitro* conditions.

CO3: Students will learn modern tools and techniques of plant genetic engineering.

CO4: Students will able to understand the various methods of plant transformation. They will also study the importance of genetic modified plants in detail.

CO5: Students will learn various applications of plant genetic engineering. They will also learn various issues and processes of patenting in plant biotechnology.

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours: 12

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

Unit-III Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

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

Suggested Books and References:

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. SandhyaMitra. 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.

Suggested E-resources

- https://microbenotes.com/plant-tissue-culture-steps/
- https://gyansanchay.csjmu.ac.in/wp-content/uploads/2022/02/Tissue-Culture-Notes.pdf
- https://www.britannica.com/science/genetic-engineering
- https://archive.nptel.ac.in/courses/102/103/102103013/
- https://www.genome.gov/genetics-glossary/Genetic-Engineering

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9113T**
Title of the course	**SECONDARY METABOLITES AND BIOPROCESS ENGINEERING**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the in-depth knowledge about the plant secondary metabolites and their large scale production.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand different types of secondary metabolites and Knowledge generation of medicinal plants and various bioactive molecules

CO2: Study basic pathway for production of secondary metabolites and Standardization of isolation and extraction protocols of secondary metabolites

CO3: Learn about different types of bioreactors and concept of bioprocess engineering and Scale up production of Secondary metabolites

CO4: Understand role of culture system in production of important drugs. Drug discoveries from medicinal plants.

CO5: Learning of genetic engineering tools for heterologous expression of genes to enhance secondary metabolite production, concept generation of functional foods and Nutraceuticals

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours: 12

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

Unit-III Lecture hours: 12

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

Unit-IV Lecture hours: 12

Production of pharmaceutically important drugs in culture: Alkaloids (*Catharanthus*, *Nicotiana, Papaver*), anti-tumour agents (taxol, podophyllotoxins, camptothecine), saponins and sterols (diosgenin, guggul, ginseng), food additives (sweetners, flavours and colours). mi RNA based

regulation of secondary metabolite biosynthesis in plants. Future perceptive of Drug discoveries from Medicinal Plants. Basic concepts of nanomedicines.

Unit-V Lecture hours: 12

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

Suggested Books and References:

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

Suggested E-resources

- https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBT1301.pdf
- https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/bioprocess-engineering
- https://mycourses.aalto.fi/pluginfile.php/917762/mod_resource/content/1/1.%20Bioprocess%20Engineering%20Principles_second%20edition_koko%20kirja.pdf
- https://link.springer.com/journal/449

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9114T**
Title of the course	**MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the in-depth knowledge of molecular plant pathology and disease management in plants.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Plant disease diagnosis by serological and molecular methods.

CO2: To learn the application of information technology and bioinformatics in plant pathology.

CO3: To have a brief idea about GIS and Remote sensing techniques in plant pathology.

CO4: To know about institute of repute of plant pathology in India and Abroad.

CO5: Learn about integrated pest management to reduce the risk of use of chemical agents for control

Syllabus

Unit-I Lecture hours: 12

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

Unit –II Lecture hours: 12

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

Unit –III Lecture hours: 12

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

Unit- IV Lecture hours: 12

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

Unit- V Lecture hours: 12

Breeding for disease resistance, marker assisted, in vitro methods, Transgenics: Coat protein mediated resistance (CPMR), antisense and gene silencing. Candidate genes to combat microbial pathogens (Chitinase,Thionine, Permatins, Lysozymes and Lectins), Ribosome inactivating proteins-RIPs, plantibodies and enhanced secondary metabolite production.

Suggested Books and References:

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

Suggested E-resources

- https://agri-bsc.kkwagh.edu.in/uploads/department_course/PATH-_121_FUNDAMENTALS_OF_PLANT_PATHOLOGY.pdf
- https://bsppjournals.onlinelibrary.wiley.com/journal/13643703
- https://www.sciencedirect.com/journal/physiological-and-molecular-plant-pathology
- https://link.springer.com/journal/10327

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9115T**
Title of the course	**APPLICATIONS OF MICROBIAL TECHNOLOGY**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the in-depth knowledge of various applications of microbial technology in pollution control, food industries and preservation of pharmaceutical products.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand role of microorganism in agriculture.
CO2: Gain knowledge about the application of microbes in environmental studies
CO3: Learn about microbial degradation of pesticides and toxic chemicals
CO4: Understand the role of micro-organisms in food industry
CO5: Assess the role of microbes in preservation technology

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours: 12

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

Unit-III Lecture hours: 12

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

Unit-IV Lecture hours: 12

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

Unit-V Lecture hours: 12

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

Suggested Books and References:

1. Food Microbiology; William C Frazier and Dennis C. Westhoff. Tata Mgraw Hill. 2008.
2. Microbiology; M.J., Prescott, J.P Harley and D.A. Klein..5th Edition, WCBMcGrawHill, New York. 2002.
3. General Microbiology; R.Y. Stanier, E.A. Adelberg and J.L. Ingram. 5th Ed., Prentice Hall of India Pvt. Ltd., New Delhi. 1991.
4. Introduction to Microbiology;A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
5. A Text Book of Microbiology: R. C. Dubey and Maheshwari. S Chand & Company Ltd. 2009.
6. Experiments in Microbiology, Plant pathology and Biotechnology, K. R. Aneja. New Age international Publishers, 2004.
7. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007.
8. Adams, M.R. and Moss, M.O. 2008. Food Microbiology, RSC Publishing, Cambridge, UK.
9. Benwart, G.J. 1987. Basic Food Microbiology, CBS Publishers & Distributors, New Delhi.
10. Deak, T. and Beuchat, L.R. 1996. Hand Book of Food Spoilage yeasts, CRC
11. Frazier, W.C., and Westhoff, D.C. 1988. Food Microbiology (Reprint 1995), Tata McGraw Hill Publishing Ltd., New Delhi.
2. Garbutt, J. 1997. Essentials of Food Microbiology, Arnold – International Students edition, London.
3. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons, Inc, New York.
4. AshutoshKar, 2008. Pharmaceutical Microbiology, New Age International Publishers,New Delhi.
15. Trivedy, R.K., Goel, P.K. and Trishal, C.L. 1987. Practical methods in Ecology and Environmental science. Environmental publishers.
16. Manivasakam, N. 2001. Chemical and Microbial analysis of mineral and packaged drinking waters. Sakthi Book Service, Coimbatore.

Suggested E-resources

- https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/4/PG_M.Sc._Microbiology_36442%20Microbial%20Biotechnology.pdf
- https://www.biologydiscussion.com/microbial-biotechnology-2/microbial-biotechnology-biotechnology-2/71609
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4030981/
- https://ocw.mit.edu/courses/20-106j-systems-microbiology-fall-2006/pages/lecture-notes/
- https://unesdoc.unesco.org/ark:/48223/pf0000049449

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9116T**
Title of the course	**BIOSYSTEMATICS–II**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the in-depth knowledge of various aspects of plant taxonomy.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand the method of plant collection and preservation of samples.
CO2: Learn about the documentation of taxonomic literature.
CO3: Assess the concept of evolution of characters and their application in taxonomy
CO4: Gain the knowledge of current advancement in plant taxonomy
CO5: Explore evolutionary history of angiosperm

Syllabus

Unit-I Lecture hours: 12

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

Unit-II Lecture hours**:** 12

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

Unit-III Lecture hours**:** 12

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

Unit-IV Lecture hours**:** 12

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

Unit-V Lecture hours**:** 12

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

Suggested Books and References:

1. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Gurucharan Singh (2010). Plant Systematics: An Integrative Approach. Science Publisher, Enfield, NH, USA.
3. Harris, J.G. and Harris, M.W. (2001). Plant identification terminology: An illustrated Glossory. Spring Lake Publisher.
4. Nei, M. and S. Kumar (2000). Molecular Evolution and Phyllogenetics. Oxford University Press, New York.

5. Semple, l. and Steel, M.A. (2003). Phyllogenetics. Oxford University Press, Oxford.
6. Simpson, M.G.(2006). Plant Systematics. Elsevier, Amsterdam.
7. Stuessy, T.F. (2006). Plant taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press New York.

Suggested E-resources

- https://libguides.bodleian.ox.ac.uk/plant_taxonomy/databases
- https://guides.lib.uw.edu/c.php?g=342081&p=2297945
- https://open.lib.umn.edu/horticulture/chapter/2-1-plant-taxonomy/
- https://guides.lib.uw.edu/research/plant_taxonomy

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9117T**
Title of the course	**APPLIED PHYCOLOGY**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the in-depth knowledge of various applied aspects of phycology.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Understand application of algae for biodiesel production
CO2: Learn about the high value by-products of bioprocess engineering
CO3: Understand the role of algae in nanoparticle synthesis and nanoecotoxicology
CO4: Gain knowledge about role of algae in bioremediation
CO5: Understand the genetic engineering of algae

Syllabus

Unit –I Lecture hours**:** 12

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

Unit –II Lecture hours**:** 12

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

Unit –III Lecture hours**:** 12

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

Unit –IV Lecture hours**:** 12

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

Unit –V Lecture hours**:** 12

Synthetic biology of Algae: Introduction of synthetic biology, Genetic modification of Algae, inducible promoters, reporters, application of algal synthetic biology. Algae as biofertilizers. Algal Bioplastic, Commercialization of algal strains for education purpose. Bioinformatics tools and databases.

Suggested Books and References:

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

Suggested E-resources

- https://link.springer.com/journal/10811
- https://brphycsoc.org/applied-phycology/
- https://www.springer.com/series/7591?srsltid=AfmBOooYsACPPYrUapK6DZhR5RCgoSd3T2JjfoGvKsX3HbMAU_6jn0KI
- https://openaccesspub.org/advances-in-plant-biology/article/530
- https://plantlet.org/role-of-algae-in-different-industry/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9118T**
Title of the course	**COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40 hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

Objective of this course is toprovide the in-depth knowledge of various applied aspects of phycology.

Course Learning Outcomes

After completion of this course, students will be able to

CO1: Learn about the micropropagation technology
CO2: Commercialization of micropropagation technique
CO3: Understand about greenhouse technology
CO4: Understand application of micropropagation technology for commercialization of important groups of plants
CO5: Understand the industrial scale setup based on micropropagation

Syllabus

Unit-I Lecture 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 Lecture 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 Lecture 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 Lecture 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 Lecture 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.

Suggested Books and References:

1. Pierik, RLM (1987) *In vitro* culture of Higher Plants, MartinusNijhoff 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

Suggested E-resources

- https://www.sciencedirect.com/book/9780081000687/applied-plant-genomics-and-biotechnology
- https://link.springer.com/journal/11240
- https://www.kspbtjpb.org/main.html
- https://www.gavinpublishers.com/journals/details/journal-of-tissue-culture-and-bioengineering

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9119P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, APPLICATIONS OF MICROBIAL TECHNOLOGY and APPLIED PHYCOLOGY).

Course Learning Outcomes

CO1: Understand about various chromatographic tools
CO2: Understand practical applications of microbial technology.
CO3: Understand biotechnological approaches for the production of bioactive compounds.
CO4: Understand application of algae for biodiesel production
CO5: Learn about the high value by-products of bioprocess engineering

Syllabus

Practicals: SECONDARY METABOLITES AND BIOPROCESS ENGINEERING

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

Practicals: APPLICATIONS OF MICROBIAL TECHNOLOGY

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

9. Viable count of bacteria in milk.
10. Potability analysis of drinking water.
11. Isolation of *Rhizobium* from root nodule.

Practicals: APPLIED PHYCOLOGY

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

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Biotechnology – Secondary Metabolites by K.G. Ramawat& J.M. Merillon, Science Publishers Inc.
2. Natural Products from Plant II Edition by L.J. Cseke et. al., Taylor and Francis.
3. Bioactive Molecules and Medicinal Plants by K.G. Ramawat and J.M. Merillon, Springer, Germany.
4. Plant-derived Natural Products by A.E. Osbourn & V. Lonzotti, Springer, Germany.
5. Introduction to Microbiology; A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
6. A Text Book of Microbiology: R. C. Dubey and Maheshwari. S Chand & Company Ltd. 2009.
7. Andersen RA (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
8. Cole KM and Sheath RG (1990). Biology of the Red Algae. Cambridge Univ. Press, Cambridge.

Suggested E-resources

- https://microbenotes.com/thin-layer-chromatography/
- https://www.mlsu.ac.in/econtents/2189_expriment%202.pdf
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9120P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, APPLICATIONS OF MICROBIAL TECHNOLOGY and COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES).

Course Learning Outcomes

CO1: Understand about various chromatographic tools
CO2: Understand practical applications of microbial technology.
CO3: Understand biotechnological approaches for the production of bioactive compounds.
CO4: Learn about the practical aspects of micropropagation technology
CO3: Understand about greenhouse technology

Syllabus

Practicals: SECONDARY METABOLITES AND BIOPROCESS ENGINEERING

17. Extraction and preparation of crude extract for value addition.
18. TLC and/or Paper Chromatography of various compounds – alkaloids, food additives.
19. Handling of spectrophotometer and _λ_max determination and study of some advance analytical instruments/techniques.
20. HPLC profiling of Selected Plant material: separation of secondary products, preparation of samples for HPLC (dilutions, filtration by membrane, loading and calculation of data).
21. Column chromatography for isolation of pure compound.
22. Identification of 10 local medicinal plants and their usage.
23. Quantitative tests for alkaloids, steroids, terpens, phenolics etc.
24. Media preparation for callus and Cell Suspension culture.
25. Initiation of callus and cell suspension culture.
26. Initiation of Hairy Root cultures for secondary metabolites production.
27. Designing of scale up experiments using Bioreactor for cell suspension and Hairy root culture.
28. Chemical diversity analysis and correlation with genetic diversity of that plant.
29. Media preparation for fungal cultures.
30. Isolation, culture and Identification of some important fungi for metabolite production.
31. Visit to pharmaceutical/drug/ Natural product producing industry.
32. Market survey for availability of various functional food and Neutraceuticals

Practicals: APPLICATIONS OF MICROBIAL TECHNOLOGY

12. Isolation of microbes from rhizosphere and rhizoplane.
13. Determination of BOD of waste-water sample.
14. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
15. Methylene blue reductase test to determine the quality of milk sample.
16. Study of food-spoilage microorganisms in fresh, canned, fermented food and meat.
17. Production and analysis of SCP: *Spirulina*, yeast, *Chlorella*, mushroom.

18. Production of yoghurt using specific starter cultures.
19. Preparation of alcohol from fruit juices.
20. Viable count of bacteria in milk.
21. Potability analysis of drinking water.
22. Isolation of *Rhizobium* from root nodule.

Practicals: COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES

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

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Biotechnology – Secondary Metabolites by K.G. Ramawat& J.M. Merillon, Science Publishers Inc.
2. Bioactive Molecules and Medicinal Plants by K.G. Ramawat and J.M. Merillon, Springer, Germany.
3. Plant-derived Natural Products by A.E. Osbourn & V. Lonzotti, Springer, Germany.
4. Introduction to Microbiology; A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
8. Pierik, RLM (1987) *In vitro* culture of Higher Plants, MartinusNijhoff Publishers, Dordrecht, The Netherlands.
9. Prakash, J. and Pierik, RLM (Eds.) 1992 "Plant Biotechnology: Commercial Prospects and Problems" Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
10. Hartmann, HT, Kestar, DE, Davis, FT and Geneve RL 1997. Plant Propagation – Principles and Practices. Sixth Edition, Pretice Hall Inc. New Jersey, USA.

Suggested E-resources

- https://microbenotes.com/thin-layer-chromatography/
- https://www.mlsu.ac.in/econtents/2189_expriment%202.pdf
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9121P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, BIOSYSTEMATICS–II and APPLIED PHYCOLOGY).

Course Learning Outcomes

CO1: Understand about various chromatographic tools
CO2: Understand practical related to the biosystematics.
CO3: Understand biotechnological approaches for the production of bioactive compounts.
CO4: Preparing herbarium sheets and its management
CO5: Learn about the high value by-products of bioprocess engineering

Syllabus

Practicals: SECONDARY METABOLITES AND BIOPROCESS ENGINEERING

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

Practicals: BIOSYSTEMATICS–II

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

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

2. Cladograms construction and analysis.
3. Techniques of preparing herbarium sheets and its management.
4. Collection and identification of at least 25 plants belonging to different families. Prepare

herbarium sheets and digitize it.

Practicals: APPLIED PHYCOLOGY

8. Isolation of genomic DNA from algae
9. Separation of algal pigments using TLC
10. Amplification of DNA barcoding gene for molecular systematics
11. Demonstration of CYANOBASE, and retrieving of gene sequences for multiple sequence alignment for candidate gene for making phylogenetic tree using (MEGA 5.0, CLUSTAL X etc)
12. Determination of lipid peroxidation and hydrogen peroxide content in stressed and non-stressed cyanobacterium
13. DNA isolation, primer designing and PCR amplification of 16S rDNA sequences from *Anabaena*sp PCC 7120
14. Isolation of algal oil using Soxhlet apparatus

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Biotechnology – Secondary Metabolites by K.G. Ramawat& J.M. Merillon, Science Publishers Inc.
2. Natural Products from Plant II Edition by L.J. Cseke et. al., Taylor and Francis.
3. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
4. Gurucharan Singh (2010). Plant Systematics: An Integrative Approach. Science Publisher, Enfield, NH, USA.
5. Harris, J.G. and Harris, M.W. (2001). Plant identification terminology: An illustrated Glossory. Spring Lake Publisher.
6. Andersen RA (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
7. Cole KM and Sheath RG (1990). Biology of the Red Algae. Cambridge Univ. Press, Cambridge.

Suggested E-resources

- https://microbenotes.com/thin-layer-chromatography/
- https://www.mlsu.ac.in/econtents/2189_expriment%202.pdf
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9122P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (SECONDARY METABOLITES AND BIOPROCESS ENGINEERING, BIOSYSTEMATICS–II and COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES).

Course Learning Outcomes

CO1: Understand about various chromatographic tools
CO2: Understand practical related to the biosystematics.
CO3: Understand biotechnological approaches for the production of bioactive compounds.
CO4: Preparing herbarium sheets and its management
CO5: Learn about the practical applications of plant tissue culture techniques.

Syllabus

Practicals: SECONDARY METABOLITES AND BIOPROCESS ENGINEERING

17. Extraction and preparation of crude extract for value addition.
18. TLC and/or Paper Chromatography of various compounds – alkaloids, food additives.
19. Handling of spectrophotometer and _λ_max determination and study of some advance analytical instruments/techniques.
20. HPLC profiling of Selected Plant material: separation of secondary products, preparation of samples for HPLC (dilutions, filtration by membrane, loading and calculation of data).
21. Column chromatography for isolation of pure compound.
22. Identification of 10 local medicinal plants and their usage.
23. Quantitative tests for alkaloids, steroids, terpens, phenolics etc.
24. Media preparation for callus and Cell Suspension culture.
25. Initiation of callus and cell suspension culture.
26. Initiation of Hairy Root cultures for secondary metabolites production.
27. Designing of scale up experiments using Bioreactor for cell suspension and Hairy root culture.
28. Chemical diversity analysis and correlation with genetic diversity of that plant.
29. Media preparation for fungal cultures.
30. Isolation, culture and Identification of some important fungi for metabolite production.
31. Visit to pharmaceutical/drug/ Natural product producing industry.
32. Market survey for availability of various functional food and Neutraceuticals

Practicals: BIOSYSTEMATICS–II

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

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

2. Cladograms construction and analysis.

3. Techniques of preparing herbarium sheets and its management.

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

Practicals: COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES

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

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Biotechnology – Secondary Metabolites by K.G. Ramawat& J.M. Merillon, Science Publishers Inc.
2. Natural Products from Plant II Edition by L.J. Cseke et. al., Taylor and Francis.
3. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
6. Harris, J.G. and Harris, M.W. (2001). Plant identification terminology: An illustrated Glossory. Spring Lake Publisher.
7. 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.
8. Nelson, PV 1991. Greenhouse operation and Management (Fourth Edition), Prentice Hall Inc. New Jersey, USA.

Suggested E-resources

- https://microbenotes.com/thin-layer-chromatography/
- https://www.mlsu.ac.in/econtents/2189_expriment%202.pdf
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/
- https://link.springer.com/journal/11240
- https://sivb.org/publications/in-vitro-plant.html

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9123P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, APPLICATIONS OF MICROBIAL TECHNOLOGY and APPLIED PHYCOLOGY).

Course Learning Outcomes

CO1: Understand the effect of fungicides on the germination and growth of plant pathogenic fungi

CO2: Understand practical applications of microbial technology.

CO3: Understand biotechnological approaches for the production of bioactive compounds.

CO4: Understand application of algae for biodiesel production

CO5: Learn about the high value by-products of bioprocess engineering

Syllabus

Practicals: MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT

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

Practicals: APPLICATIONS OF MICROBIAL TECHNOLOGY

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

Practicals: APPLIED PHYCOLOGY

1. Isolation of genomic DNA from algae
2. Separation of algal pigments using TLC
3. Amplification of DNA barcoding gene for molecular systematics
4. Demonstration of CYANOBASE, and retrieving of gene sequences for multiple sequence

alignment for candidate gene for making phylogenetic tree using (MEGA 5.0, CLUSTAL X etc)

5. Determination of lipid peroxidation and hydrogen peroxide content in stressed and non-stressed cyanobacterium
6. DNA isolation, primer designing and PCR amplification of 16S rDNA sequences from *Anabaena*sp PCC 7120
7. Isolation of algal oil using Soxhlet apparatus

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Essential Plant Pathology, Gail L. Schumann and Cleora J. D'Arcy C H Dickinson , J A Lucas, 2006.
2. A Text books of Modern Plant Pathology, K. S. Bilgrami and H. C. Dube, Vikas Publishing House Pvt. Ltd., 1996.
3. Introduction to Microbiology; A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
4. A Text Book of Microbiology: R. C. Dubey and Maheshwari. S Chand & Company Ltd. 2009.
5. Andersen RA (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
6. Cole KM and Sheath RG (1990). Biology of the Red Algae. Cambridge Univ. Press, Cambridge.

Suggested E-resources

- https://bsppjournals.onlinelibrary.wiley.com/journal/13643703
- https://www.mlsu.ac.in/econtents/2189_expriment%202.pdf
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9124P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, APPLICATIONS OF MICROBIAL TECHNOLOGY and COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES).

Course Learning Outcomes

CO1: Understand the effect of fungicides on the germination and growth of plant pathogenic fungi
CO2: Understand practical applications of microbial technology.
CO3: Understand biotechnological approaches for the production of bioactive compounds.
CO4: Learn about the practical aspects of micropropagation technology
CO3: Understand about greenhouse technology

Syllabus

Practicals: MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT

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

Practicals: APPLICATIONS OF MICROBIAL TECHNOLOGY

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

Practicals: COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES

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

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Diseases of Crop Plants in India, G. Rangaswami and A. Mahadevan, Printice Hall of India Publications. 1999.
2. Essential Plant Pathology, Gail L. Schumann and Cleora J. D'Arcy C H Dickinson , J A Lucas, 2006.
3. Introduction to Microbiology; A.S. Rao. Prentice-Hall of India Pvt Ltd., Nerw Delhi. 1997.
4. Pierik, RLM (1987) *In vitro* culture of Higher Plants, MartinusNijhoff Publishers, Dordrecht, The Netherlands.
5. Prakash, J. and Pierik, RLM (Eds.) 1992 "Plant Biotechnology: Commercial Prospects and Problems" Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Hartmann, HT, Kestar, DE, Davis, FT and Geneve RL 1997. Plant Propagation – Principles and Practices. Sixth Edition, Pretice Hall Inc. New Jersey, USA.

Suggested E-resources

- https://www.bspp.org.uk/publications/molecular-plant-pathology/
- https://bsppjournals.onlinelibrary.wiley.com/journal/13643703
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9125P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, BIOSYSTEMATICS–II and APPLIED PHYCOLOGY).

Course Learning Outcomes

CO1: Understand about the various plant pathogenic fungi.
CO2: Understand the seed borne pathogens.
CO3: Understand biotechnological approaches for the production of bioactive compounds.
CO4: Preparing herbarium sheets and its management
CO5: Learn about the high value by-products of bioprocess engineering

Syllabus

Practicals: MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT

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

Practicals: BIOSYSTEMATICS–II

1. Description and identification of plants of following families at genus and species levels using flora-
   - **Commelinids:**Arecaceae, Poaceae, Cyperaceae.
   - **Rosids:**Euphorbiaceae, Rosaceae, Fabaceae and Cucurbitaceae.
   - **Asterids:** Solanaceae, Lamiaceae, Apiaceae and Asteraceae**.**

2**.** Cladograms construction and analysis.

3. Techniques of preparing herbarium sheets and its management.

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

Practicals: APPLIED PHYCOLOGY

15. Isolation of genomic DNA from algae
16. Separation of algal pigments using TLC
17. Amplification of DNA barcoding gene for molecular systematics
18. Demonstration of CYANOBASE, and retrieving of gene sequences for multiple sequence alignment for candidate gene for making phylogenetic tree using (MEGA 5.0, CLUSTAL X etc)
19. Determination of lipid peroxidation and hydrogen peroxide content in stressed and non-stressed cyanobacterium

20. DNA isolation, primer designing and PCR amplification of 16S rDNA sequences from *Anabaena*sp PCC 7120
21. Isolation of algal oil using Soxhlet apparatus

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

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. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
4. Gurucharan Singh (2010). Plant Systematics: An Integrative Approach. Science Publisher, Enfield, NH, USA.
5. Harris, J.G. and Harris, M.W. (2001). Plant identification terminology: An illustrated Glossory. Spring Lake Publisher.
6. Andersen RA (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
7. Cole KM and Sheath RG (1990). Biology of the Red Algae. Cambridge Univ. Press, Cambridge.

Suggested E-resources

- https://microbenotes.com/thin-layer-chromatography/
- https://www.mlsu.ac.in/econtents/2189_expriment%202.pdf
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9126P**
Title of the course	**DSE Lab**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals based on theory papers (MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT, BIOSYSTEMATICS–II and COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES).

Course Learning Outcomes

CO1: Understand about various plant pathogenic fungi
CO2: Understand various seed born diseases.
CO3: Description and identification of plants belonging to various families.
CO4: Preparing herbarium sheets and its management
CO5: Learn about the commertial applications of plant tissue culture techniques.

Syllabus

Practicals: MOLECULAR PLANT PATHOLOGY AND DISEASE MANAGEMENT

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

Practicals: BIOSYSTEMATICS–II

1. Description and identification of plants of following families at genus and species levels using flora-
   - **Commelinids:**Arecaceae, Poaceae, Cyperaceae.
   - **Rosids:**Euphorbiaceae, Rosaceae, Fabaceae and Cucurbitaceae.
   - **Asterids:** Solanaceae, Lamiaceae, Apiaceae and Asteraceae**.**
2. Cladograms construction and analysis.
3. Techniques of preparing herbarium sheets and its management.
4. Collection and identification of at least 25 plants belonging to different families. Prepare herbarium sheets and digitize it.

Practicals: COMMERCIALIZATION OF MICROPROPAGATION TECHNOLOGIES

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

External practical examination - 80 Marks

- Major practical exercise – 24 Marks
- Minor practical exercise – 10 Marks
- Minor practical exercise – 10 Marks
- Identification and comments of spots (8) – 16 Marks
- Record- 10 Marks
- Viva-Voce- 10 Marks

Suggested Books and References:

1. Plant Pathology, R.S. Mehrotra,. Tata McGraw Hill Publishing Company, New Delhi. 1989.
2. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
3. Harris, J.G. and Harris, M.W. (2001). Plant identification terminology: An illustrated Glossory. Spring Lake Publisher.
4. 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.
5. Nelson, PV 1991. Greenhouse operation and Management (Fourth Edition), Prentice Hall Inc. New Jersey, USA.

Suggested E-resources

- https://microbenotes.com/thin-layer-chromatography/
- https://www.mlsu.ac.in/econtents/2189_expriment%202.pdf
- https://www.sciencedirect.com/science/article/abs/pii/S0168952507000364
- https://wordpress.clarku.edu/debrobertson/laboratory-protocols/dna-extraction-from-marine-algae-and-seagrasses/
- https://link.springer.com/journal/11240
- https://sivb.org/publications/in-vitro-plant.html

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Botany
M.Sc. Botany
Semester – IV

Code of the course	**BOT9127S**
Title of the course	**DSE Lab (Research Orientation in Plant Sciences)**
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Practical- 120 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Botany as one of the subjects in B.Sc.

Objectives of the Course

This course is designed to provide the advance knowledge of practicals and current trents in plant sciences.

Course Learning Outcomes

CO1: Understand the research methodology
CO2: Understand various laboratory safety practices.
CO3: Understand about the proper functions, principle and applications of various instruments.
CO4: Understand the scientific writing skills.
CO5: Preparation of dissertation report and PowerPoint presentation.

Description: Students have to work on selected research problems and have to submit the hardcopy of dissertation report at the department. Finally, during the End Semester practical examinations, students have to give a PowerPoint Presentation of Research Orientation in Plant Sciences for evaluation.

External examination - 80 Marks

Dissertation Report

- Review of Literature :15
- Methodology :10
- Outcome :15
- Seminar :25
- Viva – voce :15

Suggested E-resources

- https://dspace.uzhnu.edu.ua/jspui/bitstream/lib/53968/1/Molecular%20Biology%20Practicals.pdf
- https://dspace.uzhnu.edu.ua/jspui/bitstream/lib/53968/1/Molecular%20Biology%20Practicals.pdf
- https://www.oup.com.au/__data/assets/pdf_file/0019/135073/Chemistry-for-QLD_9780190313395_sample-chapter-13_secure.pdf
- https://www.vedantu.com/physics/spectroscopy
- https://www.genome.gov/genetics-glossary/Polymerase-Chain-Reaction-PCR
- https://personal.utdallas.edu/~brikowi/Teaching/Field_Methods/Using_pH_Meter.html