Bajaj College of Science, Wardha

Department of Botany

M.Sc. (Botany) Course Structure and Syllabus

From Academic Year 2021-22 Onwards

The M.Sc. (Botany) programme would be a four-semester programme with minimum 64 credits.

Theory/ Practical	Course	Credit	Type
Semester I			
Paper I	Microbiology, Algae, Fungi, Microscopy & Centrifugation	4	Core
Paper II	Bryohytes, Pteridophytes & Plant Microtechniques	4	Core
Paper III	Paleobotany, Gymnosperms, Spectrophotometry & Chromatography	4	Core
Paper IV	Cytogenetics & Cell/Tissue Structure methodology	4	Core
Practical I	Practical I based on paper I and paper II	4	Core
Practical II	Practical II based on paper III and IV	4	Core
Seminar	Seminar on any semester related theory	1	Core
Semester II			
Paper V	Plant Physiology, Biochemistry & analytical pharmacognosy	4	Core
Paper VI	Plant Development, Reproduction & Phytochemistry	4	Core
Paper VII	Cell, Molecular Biology-I & Data Collection, Documentation & Photography	4	Core
Paper VIII	Angiopserms-I, Ethnobotany & Scientific Writing	4	Core
Practical III	Practical based on paper V and VI	4	Core
Practical IV	Practical based on VII and VIII	4	Core
Seminar	Seminar on any semester related theory	1	Core

Theory/ Practical	Course	Credit	Type
Semester III			
Paper IX	Plant Ecology, Conservation, Herbal Cosmetics & Medicine	4	Core
Paper X	Angiosperms- II & Plant Nursery Management	4	Core
Paper XI	Molecular Biology & Plant Biotechnology-I	4	Elective
Paper XI	Mycology & Plant Pathology-I	4	Elective
Paper XII	Aesthetic Botany	4	Subject centric Foundation Course
Practical V	Practical V based on paper IX and paper X		
Practical VI	Practical VI based on paper XI - Molecular Biology & Plant Biotechnology		
Practical VI	Practical VI based on paper XI- Mycology & Plant pathology		
Semester IV			
Paper XIII	Cell & Molecular Biology-II	4	Core
Paper XIV	Plant Biotechnology & Bioinformatics	4	Core
Paper XV	Molecular Biology & Plant Biotechnology-II	4	Elective
Paper XV	Mycology & Plant Pathology-II	4	Elective
Paper XVI	Plant Resources	4	Subject centric Foundation Course
Practical VII	Practical based on paper XIII and XIV		
Practical VIII	Practical based on research project		

Master of Science (Botany)	**Semester I**
Course Code	**PG-BOT (06)-S1-T1**
Course Name	**Microbiology, Algae, Fungi, Microscopy & Centrifugation**
Course Credit	**04**
Course Working hours	**60 hrs**
Course Structure	**Theory and Practicals**

Course objectives: The main objective of the course is to increase understanding of bacteria, viruses, fungi, and algae. Study of morphology, anatomy, reproduction and developmental changes of these primitive groups will give students a classical approach and their study should create a knowledge base in understanding lower group plant diversity, economic values, taxonomy of lower group of plants.

Course Learning Outcomes:
CO1: Students will be able to describe general history of microbiology; structure, morphology, reproduction in bacteria; morphology and reproduction of viruses like TMV, bacteriophage; general account, ultrastructure, nutrition, reproduction, economic importance of bacteria, archaebacteria and cyanobacteria.
CO2: Students will compare and describe classification, diversity, thallus organization, life cycle, economic importance of algae (*Volvox*, *Ulothrix*, *Gracillaria*, *Padina*), lichens and mycorrhiza.
CO3: Students will construct and apply classification, cytology, general account in the life cycle of fungi
Penicillium, *Plasmodiophora*, *Perenospora*, *Cunninghamella*, *Phyllactinia*, and *Chaetomium*.
CO4: Students will analyze and categorize algal and fungal morphological variation.
CO5: Students will compose and comply concept behind preparation of molar solutions, stock solution, pH measurements and preparation of buffers; principle and application of centrifugation techniques.
CO6: Students will assess Principle, working, application of microscopy and microscopic techniques.

Course Content:

Module I	**Prokaryotes and Viruses**	**15 hrs**

General Microbiology: History- Contributions made by Koch's Postulates
Bacteria: structure, morphology, reproduction
Viruses: general account, morphology and ultrastructure of TMV, bacteriophage,
Archaebacteria: general account, ultrastructure, nutrition and reproduction biology and economic importance Cyanobacteria: Life cycle and characters of *Microcystis*, *Lyngbya*, *Nostoc*, *Gloeotrichia*

Module II	**Algae, lichens and mycorrhiza**	**15 hrs**

Classification of Algae up to orders, recent classification, algae in diversified habitats (terrestrial, freshwater, marine), thallus organization: origin and evolution, fossil algae
Life cycle of *Volvox*, *Ulothrix*, *Gracillaria* and *Padina*, techniques of culturing algae, algal biofertilizers, algae causing biological hazards
Lichen: Role of lichen in biomonitoring, type, morphology and reproduction
Mycorrhiza: Type, distribution and significance with reference to agriculture and forestry

Module III	**Fungi**	**15 hrs**

General account: Recent classification of fungi
Physiology of fungi (with reference to biotrophs, hemibiotrophs, symbionts) fungal cytology, heterothallism, karyokinensis, parasexual cycle, general account of spore bearing organs and their ar- rangements in various groups of fungi, spore release and dispersal Life cycle of *Penicillium*, *Plasmodiophora*, *Perenospora*, *Cunninghamella*, *Phyllactinia*, and *Chaetomium*
Study of the following diseases with reference to symptoms, causal organism and disease cycle: paddy blast, wheat rust, smut of jowar, black arm of cotton, red rot of sugarcane, citrus canker, and potato blight
Deuteromycetes: Life cycle of *Helminthosporium* and *Colletotrichum*

Module IV	Microscopy & Centrifugation	15 hrs

Microscopy: light-bright field and dark field, phase contrast, fluorescence, electron microscopy, con- focal microscopy, micrometry
Making solution: moles and molarity, stock solution and dilution, pH measurements and preparation of buffers
Centrifugation techniques: principle and applications, sedimentation coefficient and diffusion coef- ficient, zonal and differential centrifugation, ultracentrifugation, density gradient centrifugation

Practical topics	Practicals based on theory paper- Microbiology, Algae, Fungi, Microscopy & Centrifugation

1. Classification and type study of the following classes:
1a. Prochlorophyta: Prochloron, chlorophyta: *Pandorina*, *Eudorina*, *Stigeoclonium*, *Chlorella*, *Scenedesmus*, *Caulerpa*, *Valonia*, *Acetabularia*; *Phaeophyta*: *Spocelaria*, *Padina*, *Turbinaria*; 1b. Rhodophora: *Nemalion*, *Gelidium*, *Gracilaria*, *Corallina*, *Polysiphonia*; Euglenophyta: Euglena, Phacus; 1c. Bacillariophyta: *Cycloteila*, *Synedra*, *Cymbella*, *Novicula*, *Gomphonema*.
2. Morphological Studies of Fungi (any 15 of the following)
2a. *Stemonites*, *Perenospora*, *Phytophthora*, *Albugo*, *Mucor*, *Rhizopus*, yeast, *Aspergillus*, *Penicillium*, 2b. *Chaetomium*, *Taphrina*, *Peziza*, *Erisyphe*, *Phylloctenia*, *Uncinula*, *Melompsora*, *Uromyces*,
2c. *Drechslera*, *Ravenalia*, *Ustilago*, *Polyporus*, *Morchella*, *Cyathus*, *Alternaria*, *Helminthosporium*, *Curvularia*, *Colletotrichum*, *Phoma*, *Plasmodiophora*, *Cercospora*, *Fusarium*, *Claviceps*.
3. To study the symptoms in some diseased prants (any 7 of the folowing).
Downy mildew, powdery mildew, rusts, smuts, ergot, groundnut leaf spot (Tikka disease), false smut of paddy, red rot of sugarcane, wilt disease, citrus canker, angular leaf spot of cotton, potato blight, leaf mosaic of bhindi/ papaya, leaf curl of tomato/potato/papaya, little leaf of brinjal.
4. Identification of Fungal cultures (Any 5)
Rhizopus, *Mucor*, *Aspergillus*, *Penicillum*, *Drechslera*, *Curvularia*, *Phoma*, *Colletotrichum*, *Alternaria*, and
Helminthosporium.
5. Field study: For collection and studying fungal flora

Suggested Readings

1. Anantnarayan and Panikar. Textbook of Microbiology. Orient Longman Private Limited, 2007.
2. Aneja and Jain. A Textbook of Basic and Applied Microbiology. New Age International Pub- lisher, 2008.

3. Arumugam and Kumarsan. Biotechniques. Saras Publication, Nagarcoil, 2015.
4. Atlas. Microbiology Fundamentals and Application. Macmillan Publishing Company, 1989.
5. Baveja.C.P. Textbook of Microbiology. 6th. Microbiology. Arya Publication, 2018.
6. Bendre and Pande. Introductory Botany. Rastogi Publication, Gangotri, 2011.
7. Kar, Ganguly and Santra. College botany. New Central book agency, Kolkatta. 2011.
8. Bhattacharya ,Ghosh and Hait. A Textbook of botany. New central book agency. Kolkatta, 2019.
9. G. Hait. A Textbook of Microbiology. Kolkata: New Central Book Agency, 2016.
10. I. Kaur. Textbook of Fungi. Delhi: Macmillan Publisher India, 2011.
11. S. Kumar. Diversity of Algae, Lichen and Bryophytes. Prakashan Prakashan, Meerut, 2015.
12. R.S. Mehrotra and A. Agrawal. Plant Pathology. Mcgraw Hill Publications,Chennai, 2017.
13. H. Modi. A Handbook of Elementary Microbiology. Shanti Prakashan, Delhi, 2017.
14. P. Modi. Notebook's of Microbiology. 2nd. CBS Publisher Distributor PVT Limited, 2017.
15. A. Kumarsen Regland. Algae, Fungi. Bryophytes and Plant Pathology. Saras publication, Nagarcoil, 2014.
16. P.D. Sharma. Plant Pathology. Narosa Printing House Pvt, Ltd. New Delhi, 2006.
17. Sinha and Shrivastava. An Introduction to bacteria. Vikas Publishing House Pvt Ltd, New Delhi. 1995.
18. G. Sumbali. The Fungi. 2nd. Narosa Publishing house.
19. Tembhare. Techniques in Life Sciences. Mumbai: Himalaya Publishing House Pvt Limited, 2008.

Suggested URLs/Websites:

- https://msafungi.org/
- https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod3.pdf
- http://epgp.inflibnet.ac.in/epgpdata/uploads/ epgp content/S001174BS/P001204/M011034 /ET/1479290706P9M11eTextAug13.pdf

Master of Science (Botany)	**Semester I**
Course Code	**PG-BOT (06)-S1-T2**
Course Name	**Bryophytes, Pteridophytes & Plant Microtechniques**
Course Credit	**04**
Course Working Hours	**60 hrs**
Course structure	**Theory and Practicals**

Course objectives: This course aims to prepare understanding of evolutionary diversification of early land plants. The course aims to distinguish morphological, anatomical and reproductive variations in bryophytic and pteridophytic plants.

Course Learning Outcomes:

CO1: Students will be able to describe general characters, classification system, ecology of bryophytes, fossil history of bryophytes and evolution of sporophyte

, also the general account of hepaticopsida, anthocertopsida, bryopsida.
CO2: Students will compare and describe General Characters, classification system, distribution of pteridophytes like psilopsida, lycopsida, sphenopsida and evolution of stele.
CO3: Students will compare salient features of calamitales, life cycle of *Lycopodium*, *Osmunda*, *Marsilea*, *Ophioglossum*, *Azolla*, *Gleichenia*, *Dryopteris*, cultivation and maintenance of ornamental ferns.
CO4: Students will formulate staining procedures, classification and chemistry of stains, reactive dyes and fluorochromes, cytogenetic techniques with smear and squash materials.
CO5: Students will interpret evolutionary mechanism of early land plant diversity and value the application of microtechniques for study of bryophytic and pteridophytic plants.

Course Content:

Module I	**Bryophytes**	**15 hrs**

General characters, distribution, recent system of classification, ecology of bryophytes, fossil history of bryophytes, cytology of bryophytes, regeneration in bryophytes, evolution of sporophyte- retrogressive and progressive theory.
General account of hepaticopsida: sphaerocarpales, takakiales; Anthocerotopsida : anthocerotales;
Bryopsida: sphagnales, polytrichales.

Module II	**Pteridophytes-I**	**15 hrs**

General characters, recent system of classification, distribution, evolution of stele. Psilopsida : Salient features of psilophytales,
Lycopsida : Salient features of lepidodendrales, Sphenopsida : Salient features of equisetales

Module III	**Pteridophytes-II**	**15 hrs**

Salient features of Calamitales : *Calamites*, *Annularia*, *Calomostachys*.
Study of life cycles of :*Lycopodium*, *Osmunda*, *Marsilea*, *Ophiolglossum*, *Azolla*, *Gleichenia*, *Dryopteris*. Cultivation and maintenance of ornamental ferns.

Module IV	**Plant Microtechniques**	15 hrs

Staining procedures, classification and chemistry of stains.
Reactive 32 dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags).
Cytogenetic techniques with smear squash plant materials.

Practical topics	**Practicals based on paper-Bryophytes, Pteridophytes & Plant Microtechniques**

Bryophytes:

1. Study of morphological and reproductive characters of representative members mentioned in the syllabus using section preparations, dissections and sections.
2. Preparation of permanent slides is necessary.
3. Study of bryophytes in their natural habitats.
4. Botanical excursion outside the state is compulsory to study the bryophytes

Pteridophytes:

5. Study of fossil forms (specimens and permanent micro preparations).
6. Study of living forms: Morphological, anatomical and reproductive characters of the forms mentioned in the syllabus.

Plant Microtechniques:

7. Preparations of permanent slides are essential.
8. To prepare different laboratory stains
9. To study procedure for staining different plant materials.

Suggested Readings

1 George P. (2010). Handbook of bryophyta. Rajat Publication, New Delhi.

2 Glime, J.M. Saxena, D. (1991). Uses of bryophytes. Today Tomorrow's printers and publisher,
New Delhi

3 Kumar S. (2003). Manual of practical bryophyte. Campus Books International. Delhi

4 Pandey, B.P. (1993). A textbook of botany-Bryophyta. S. Chand Company Ltd. New Delhi

5 Puri, P. (1980). Bryophytes : Morphology, growth and differentiation. Atmaram and Sons. New Delhi.

6 Rashid, A. (1998). An introduction to Bryophyta (Diversity, Development Differentiation). Vikas Publishing House Pvt. Ltd.

7 Sambamurty (2006). A textbook of bryophytes, pteridophytes, gymnosperms and paleob- otany. I.K.International Pvt. Ltd. New Delhi.

8 Yadav, P.R. (2010) Textbook of bryology. Discovery Publishing House Pvt. Ltd. New Delhi.

9 Vasishta P.C. (1974). Botany for degree students, Vol. 4 : vascular cryptogams (pterido- phyta).S. Chand Co., New Delhi

10 Sporne K.R. (1966). Morphology of pteridophytes, the structure of ferns and allied topics. Hutchinson.

11 Samuel.W.B. (1984). Selected ferns and lycopods. Ajay Book Service, New Delhi

12 Tembhare. D.M. (2008). Techniques in life sciences. Himalaya Publishing House Pvt Limited, Mumbai.

13 Arumugam and Kumarsan. (2015). Biotechniques. Saras Publication, Nagarcoil.

14 Verma and Agrawal. (2008). Cytology. S. Chand Company Pvt Limited, New Delhi

15 Dua and Garg. (2010). Biochemical methods of analysis. Narosa Publishing House Pvt Ltd, New Delhi.

16 Shrivastava. S. (2012). Molecular techniques in biochemistry and biotechnology. New Central Book Agency, Kolkatta.

17 Ghatak.G.L. (2011). Techniques and methods in biology. PHI Learning PVT Limited, New Delhi.

18 Rajan, S. (2000). Cytogenetics. Anmol Publication Pvt Limited, Delhi.

19 Roy, D. (2009). Cytogenetics. Narosa Publishing house, Pvt Limited, Delhi.

Suggested URLs/Websites:

- http://www.theplantlist.org/1.1/browse/B/
- https://bsapubs.onlinelibrary.wiley.com/doi/full/10.3732/ajb.1000316
- http://www.jnpg.org.in/WebDoc/EContent/science/General%20characters%20of%20 Pteridophytes.pdf
- http://www.theplantlist.org/1.1/browse/P/

Master of Science (Botany)	**Semester I**
Course Code	**PG-BOT (06)-S1-T3**
Course Name	**Paleobotany, Gymnopserms, Spectrophotometry & Chromatography**
Course Credit	**04**
Course Working Hours	**60 Hrs**
Course Structure	**Theory and Practicals**

Course objectives: This course aims to prepare understanding of evolutionary diversification of gymnosperms. The course aims to distinguish morphological, anatomical and reproductive variations in gymnospermic plants.

Course Learning Outcomes:

CO1: Students will be able to construct theories of preservation of plant fossils, age determination, geological time scale; systematics, reconstruction and nomenclature of fossils; applies aspects of paleobotany.
CO2: Students will explain comparative morphology and evolutionary trends of Gymnosperms like Cordaitales, Caytoniales, Glossopteridales, Pteridospermales, Cycadales, Cycadeoidales.
CO3: Students will describe general account and relationships of Gymnosperms viz Pentoxylales, Gnetales, Ephedrales, Ginkgoales, Coniferales.
CO4: Students will demonstrate principle, working and application of instruments- Spectrophotometer and chromatography.

Module I	**Paleobotany**	**15 hrs**

Introduction; Plant fossils - Theories of preservation, preparation, age determination, ge- ological time scale; Fossil record: Systematic, reconstruction and nomenclature; Applied aspects of paleobotany.

Module II	**Gymnosperms-I**	**15 hrs**

General account: Distribution (Living fossils); origin; recent systems of classification; eco- nomic importance. Comparative morphology and evolutionary tendencies of: Cordaitales, Caytoniales, Glossopteridales,

1. Pteridospermales- Lyginopteridaceae (*Colymototheca hoeninghausii* (*Lyginopteris old- homia*),*Hetarngium*, *Spherostoma*); Medullosaceae (*Medullosa*, *Trignocorpus*).
2. Cycadales- Cycadaceae; Fossil history (*Boenia*, *Nilssonia*, *Androstrobus*)

3. Cycadeoidales- Williamsoniaceae, Cycadeoidaceae

Module III	Gymnosperms-II	15 hrs

General account and relationships of- Pentoxylales, Gnetales, Ephedrales, Ginkgoales (*Ginkgo*, *Baiera*, *Trichopitys*); Coniferales (General characters, Embryogeny and phylogeny, evolution of ovuliferous scales, phylogeny)

Module IV	Spectrophotometry & Chromatography	15 hrs

Spectrophotometry: Principles and its application in biological research. Chromatography: Principles; Paper chromatography; Column chromatography, TLC, GLC, HPLC, lon exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Practical topics	Practical based on paper-Paleobotany, Gymnosperms, Spectrophotometry & Chromatography

1. Comparative Study of vegetative and reproductive parts of: *Cycas*, *Zamia*, *Cedrus*, *Abies*, *Pinus*, *Cupressus*, *Cryptomeria*, *Taxodium*, *Podocorpus*, *Agathis*, *Thuja*, *Gnetum*, *Ephedra*, *Juniperus*, *Cephalotaxus*, *Taxus*, *Ginkgo*: Morphology to be studied from Museum specimens anatomy from permanent slides only. Permanent micropreparations to be submitted by the students.
2. Study of important fossil gymnosperms from material and permanent slides.
3. Visit to pateobotanical institutes, localities and collection of specimens.
4. Field visits to ecologically different localities to study living gymnosperms.
5. To study Beer-Lambert's law for spectrophotometry.
6. To separate chlorophyll pigments by paper chromatography.
7. To measure the plant pigments by spectrophotometer.

Suggested Readings

1. Arnold, C. A. (1947). An introduction to paleobotany. McGraw-Hill Book Company. New York.
2. Holt, Rinehart Winston. (1966). Morphology and evolution of fossil plants. Springer, USA
3. Mishra, S.R. (2010). Text Book of palaeobotany. Discovery Publishing Pvt.Ltd. New Delhi.
4. Sambamurty (2006). A textbook of bryophytes, pteridophytes, gymnosperms and pale- obotany. I.K.International Pvt. Ltd. New Delhi.
5. Shukla, A.C. Misra, S.P. (1975). Essentials of paleobotany. Vikas Publishing house pvt. Ltd. Delhi
6. Stewart, W. N., Stewart, W. M., Rothwell, G. W. (2005). Paleobotany and the evolu- tion of plants. Cambridge University Press.
7. Sharma O.P. (1999) Gymnosperms. Pragati Prakashan, Meerut
8. Coulter John M. (1964). Morphology of gymnosperms. Central Book Depot, Allahabad
9. Sporne K.R. (1967). Morphology of gymnosperms: structure and evolution of primitive seed-plants. Hutchinson Co. (Publishers) Ltd., London
10. Ghatak K.L. (2011). Techniques and methods in biology. PHI Learning PVT Limited, New Delhi.
11. Shrivastava, S. (2012). Molecular techniques in biochemistry and biotechnology. New

Central Book Agency, Kolkatta.

12. Dua and Garg. (2010). Biochemical methods of analysis. Narosa Publishing House Pvt Ltd, New Delhi.
13. Jain, V.K. (2018). Fundamentals of plant physiology. Vikas Publishing House Pvt Limited,

New Delhi.

14. Shrivastava. (2005). Plant physiology and biochemistry. Rastogi Publication, Meerut.

Suggested URLs/Websites:

- http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001204/M011037/ET/1479290785P9M13eTextOct12.pdf
- http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001204/M031002/ET/1526972877P9M14 ET.pdf

Master of Science (Botany)	**Semester I**
Course Code	**PG-BOT (06)-S1-T4**
Course Name	**Cytogenetics & Cell/Tissue Structure Methodology**
Course Credit	**04**
Course working Hours	**60 Hrs**
Course Structure	**Theory and Practicals**

Course objectives: This course aims to recognize principles of Mendelian and non-Mendelian inheritance, quantitative genetics, epigenetics, cytogenetic and crop genetics resources.

Course Learning Outcomes:

CO1: Students will be able to explain Mendel's laws of inheritance, multiple alleles and isoalleles, gene interactions,, suppressors and pleiotropic genes; multigene families; extrachromosomal inheritance, chromatin organization.

CO2: Students will construct Karyotype analysis and evolution, banding patterns, chromosomal aberrations, and their use in chromosome mapping; population genetics. **CO3**: Students will illustrate molecular basis of gene mutations; transposable genetic elements; plant genetic resources, epigenetics.

CO4: Students will evaluate methods to study cell and tissue structure through whole mounts, peel mounts, squash preparations; Tissue preparations; preparation of thin sections.

Module I	**Mendelian & Classical Genetics**	**15 hrs**

Mendel's laws of inheritance; penetrance, expressivity, multiple alleles and isoalleles (example Corn, Drosophila and Nicotiana, gene interactions (non-epistatic and epistatic), Modifiers, suppressors and pleiotropic genes; multigene families (globin, immunoglobin genes);

Extrachromosomal inheritance: lnheritance of mitochondria and chloroplast genes, maternal inheritance and its effect.

Chromatin organization: rRNA genes, euchromatin and heterochromatin, C-value

paradox, Cot curve and its significance.

Module II	Chromosomal Genetics and Population Genetics	15 hrs

Karyotype analysis and evolution, banding patterns, specialized types of chromosomes: Polytene, Lampbrush, B-chromosome, sex chromosome; molecular basis of chromosome pairing.
Origin and breeding behaviour of duplications, deficiency, inversion and translocation heterozygotes, effect of aneuploidy on plants, transmission of trisomics and mono- somics and their use in chromosome mapping, complex translocation heterozygotes, translocation tester sets, Robertsonian translocation.
Population genetics: Hardy-Weinberg equilibrium, factors affecting Hardy-Weinberg Equilibrium.

Module III	Mutation and plant genetic resources	15 hrs

Mutations: Molecular basis of gene mutations; transposable genetic elements; site directed mutagenesis- definition, applications and PCR based oligonucleotide muta genesis; role of mutations in crop improvement; induction of polyploidy.
Plant Genetic Resources: importance of genetic diversity in crop improvement, and its erosion. Epigenetics: introduction, histone code, base modification, paramutations in maize, epigenetics and Lamarckism, Introduction to epigenome and epigenomics.

Module IV	Methods to study cell/tissue structures	15 hrs

Whole mounts, peel mounts, squash preparations-mitotic and meiotic chromosomes, staining of chromosomes, clearing, maceration and sectioning. Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series, paraffin infiltration, preparation of thin sections.

Practical topics	Practicals based on paper - Cytogenetics and Cell/Tissue structure methodology

1. To study cell division (mitosis and meiosis) in the given material.
2. To study the effect of mutagen treatment on germination and seedling height.
3. To study effect of mutagen on the rate of cell division.
4. To study effect of mutagen on genetic material by scoring the chromosomal aber- rations.
5. To study the translocation heterozygote in *Rheo discolor* or any other suitable material.
6. To study polytene chromosomes in Chironomus larvae.
7. To study O banding pattern of any plant material.
8. To solve the given problems on interaction of genes (at least five).
9. To study the karyotype of given organism.
10. To study the chiasma frequency in the given material.

11. To study methods of fixation, preservation and clearing and maceration of plant material.
12. To study the methods of paraffin infiltration.

Suggested Readings

- Gupta.P.K. (2015). Cytogenetics. Rastogi Publication. Meerut.
- Arora, M. (2011). Cytogenetics. Himalaya Publishing House Pvt Limited. Mumbai Mahabal, R. (2010). Fundamentals of Cytogenetics and Genetics., PHI Learning Pvt Limited, Delhi.
- Rajan, S. (2000). Cytogenetics. Anmol Publication Pvt Limited, Delhi. Roy, D.((2009). Cytogenetics. Narosa Publishing house, Pvt Limited, Delhi.
- Jahier, J (1996). Techniques of plant Cytogenetics. Oxford and IBH Publishing Copy, Limited New Delhi.
- Tyagi,S (2009). A Textbook of Cytology. Dominant Publisher Distributor, New Delhi. Arora
- ,M.P. (2013). A Textbook of Organic Evolution. Himalaya Publishing House, Pvt Limited. Verma and Agrawal. (2008). Cytology. S.Chand Company Pvt Limited, New Delhi. Dua and Garg. (2010). Biochemical Methods Of Analysis. Narosa Publishing House Pvt Ltd, New Delhi.

Suggested URLs/Websites:

- http://egyankosh.ac.in/bitstream/123456789/16312/1/Experiment-7.pdf
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=35
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2

- https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/

Template of practical examination

Practical I	Time: 6 hrs	Max. Marks= 100
Q. 1	To identify the given Cyanobacterial material A.	10
Q. 2	To identify two algal forms B, C, from the given mixture.	10
Q. 3	To identify the given fungal culture D	10
Q. 4	To identify the given plant pathogen in the given material E.	10
Q. 5	To prepare a temporary microprepration of the given Bryophytic material F and identify it	10
Q. 6	Comment on the given spot G (Cyanobacteria/Bacteria), H (Algae), I (Fungi), J (Bryophyte) K. Microscopy & Centrifugation L. Plant Microtechniques	15
Q. 7	Viva-voce	20
Q. 8	Practical Record and tour report	15

Practical II	Time: 6 hrs	Max. Marks= 100
Q. 1	To prepare a double stained microprepration of the given Pteridophytic material A and identify it.	10
Q. 2	To prepare a double stained micropreparation of the given gymnospermic material B and identify it.	10
Q. 3	Comment on the given fossil specimen C	10
Q. 4	One experiment from Cytology and Genetics D	10
Q. 5	Comment on the given spot- E. (Pteridophyte), F. (Gymnosperm), G. (Fossils), H (Cytology/Genetics), I. Spectrophotometry & Chromatography, J. Cell/tissue structure	24
Q. 6	Viva-voce	20
Q. 7	Practical Record and tour report	16

Master of Science (Botany)	Semester II
Course Code	**PG-BOT (06)-S2-T1**
Course Name	Plant Physiology, Biochemistry and Analytical Pharmacognosy
Course Credit	04
Course Working hours	**60 hrs**
Course Structure	Theory and Practicals

Course objectives: The main objective of the course is to learn concepts of carbohydrates, protein, lipids, enzymes, and various physiological processes with respect to nutrient uptake, photosynthesis, respiration and nitrogen metabolism.

Course Learning Outcomes:

CO1: Students will be able to describe and compose light reaction and dark phase of photosynthesis, C3, C4 and CAM pathways and understand differences between photorespiration and other photosynthetic pathways. Students will be able to understand various processes of plant respiration.

CO2: Students will perceive mechanisms of sensory physiology, types of plant hormones, and their biosynthesis and mechanism of action. Students will prepare and assess enzyme kinetics and regulation and properties of enzyme activity

CO3: Students will explain and demonstrate solute transport mechanisms.

CO4: Students will analyze and categorize carbohydrate, lipid and nitrogen and amino acid metabolisms.

CO5: Students will assess working principles, methods of drug evaluation, herbal extractions and testing of herbal drugs

Course Content:

Module I	**The Scope of plant physiology**	**15 hrs**

Photosynthesis: Pigments, Light, light harvesting complex, Mechanism of electron transport, Photo protective mechanism, CO_2 fixation, C3, C4 and CAM pathway, Photorespiration, the chemiosmotic-coupling hypothesis and ATP Synthesis,

Respiration:- Introduction, Glycolysis, Citric acid cycle, Oxidative pentose phosphate pathway, Plant mitochondrial electron transport system and ATP synthesis (oxidative phosphorylation).

Module II	**Plant hormones & Enzymes**	**15 hrs**

Plant hormones:- Biosynthesis, physiological effect and mechanism of action of hormones-auxins, gibberellins and cytokinins.

Sensory photobiology:- Structure, function and mechanism of phytochromes, Photoperiodism and biological clock

Enzymes: Nomenclature and classification of Enzymes, enzyme kinetics, Michaelis – Menten equation, mode and mechanism of Enzyme action (Regulation of Enzyme activity), Activators & Inhibitors of enzymes, properties of Enzymes, factors affecting Enzyme activity, isozymes.

Module III	**Transport and Metabolism**	**15 hrs**

Solute transport and photo-assimilate translocation:-Uptake transport and translocation of water, ion, solutes and macromolecules from soil through cell, across membranes, through

xylem and phloem, transpiration, mechanism of loading and unloading of photoassimilates. **Carbohydrate Metabolism:** Composition, structure and function of carbohydrates, synthesis of starch and Sucrose, catabolism (degradation) of starch and sucrose.

Lipid Metabolism: Composition, structure and function of lipids, fatty acid biosynthesis, membrane storage lipids.

Protein metabolism: Composition, structure (Ramchandran plot, secondary, tertiary and quaternary structure) and function of proteins **Metabolism of amino acids:** Composition, structure and function of amino acids, amino acid biosynthesis in Plants. **Nitrogen metabolism:** Nitrate and ammonium assimilation

Module IV	Analytical Pharmacognosy	15 hrs

Crude drugs : Introduction, classification of crude drugs.

A) Drug adulteration - types

B) Drug evaluation - 1) Morphological or organoleptic, 2) Microscopic - stomata, Trichomes, xylem, phloem, ergastic substances) 3) Chemical evaluation. 4) Physical evaluation 5) Biological evaluation -Phytochemical screening tests for secondary metabolites in crude drugs (alkaloids, flavonoids, steroids, triterpenoids, and phenolic compounds).

Practical topics	Practicals based on theory paper- Plant Physiology, Biochemistry and Analytical Pharmacognosy

1. To study the effect of time and enzyme concentration on the rate of reaction of enzymes. (e.g. amylase).
2. To study the effect of substrate concentration on enzyme activity and determination of its Km value.
3. To demonstrate the substrate inducibility of the enzyme nitrate reductase.
4. To determine amylase activity, its kinetics and sensitivity to inhibitors.
5. To determine the total carbohydrate content in the given sample.
6. To estimate total pectic substances using gravimetric method.
7. To prove Beer-Lambert's law using a suitable solution.
8. To prepare the absorption spectrum of chlorophyll and carotenoids using chlorophyll extract from leaves.
9. To determine the chlorophyll a/ chlorophyll b ratio in C3 and C4 plants.
10. To prepare a standard curve of protein (BSA) and estimate total protein content in extracts of plant material by Lowry's or Bradford's method.
11. To determine total reducing sugars by Nelson – Somogyi Method.
12. To study different methods of adulteration.
13. To study the screening tests for secondary metabolites.
14. Quantitative estimation of caffeine from coffee powder and from other sources using UV-VIS and FTIR.

Suggested Readings:

1) Acharya, M &Choudhary. (2009). Practical Plant Physiology: New Central Book Agency, Delhi.
2) Devlin, R. (2017). Outline of Plant Physiology: Scientific International Pvt Limited, New Delhi.
3) Ghosh, A.K. (2006). Plant Physiology: New Central Book Agency, Kolkata.
4) Gupta, N. & Gupta, S. (2005).Plant Physiology: Oxford and JBH Publishing .Co.Pvt Limited. Delhi.

5) Hess, D.(1996) Plant Physiology: Narosa Publishing House Pvt Limited, New Delhi.
6) Kokate, C.K., Purohit, A.P. &Gokhale, S.B. (2019). Pharmacognosy:NiraliPrakashan, Pune.
7) Jain. V. (2017) Fundamentals of Plant physiology: S Chand & Company Ltd., Ramnagar, New Delhi.
8) Lawler, D. (2001).Photosynthesis: Viva Book Private Limited, New Delhi.
9) Pande&Sinha.(2013).Plant Physiology:Vikas Publishing House PvtLimited.Noida.
10) Salisbury & Ross.(1992). Plant Physiology: Anubhav Printers Noida.
11) Shrivastava, H.S.(2006). Plant Physiology, Biochemistry and Biotechnology: Rastogi Publication Meerut.
12) Taiz., L. &Zeiger, E. (2018).Fundamentals of Plant Physiology :Sinauer Associates Inc.
13) Verma, S.K. &Verma, M. (2018) Plant Physiology, Biochemistry and Biotechnology:Vikas Publishing House Pvt Limited, New Delhi.

Suggested URLs/Websites:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=944

Master of Science (Botany)	Semester II
Course Code	**PG-BOT (06)-S2-T2**
Course Name	Plant Development, Reproduction and Phytochemistry
Course Credit	04
Course Working Hours	**60 hrs**
Course structure	Theory and Practicals

Courseobjectives: This course aims to prepare the students acquainted with a fundamental understanding of mechanisms associated with plant growth and development and differentiation of various plant organs. The course aims to distinguish anatomical and reproductive changes in flowering plants.

CourseLearningOutcomes:

CO1: Students will be able to describe seedling growth and shoot development. Students will understand the differences between leaf and root development.

CO2: Students will compare and describe male and female gametophyte developments. Students will explain the molecular mechanism of flower development.

CO3: Students will compare embryo development and illustrate embryogenesis, pistil, seed development and interpret changes associated with senescence.

CO4: Students will formulate active principles and derive methods of testing of active principles from medicinal herbs.

CourseContent:

Module I	**Plant Development**	**15 hrs**

Plant growth kinetics and patterns of growth.

Seedling growth: Tropisms; Photomorphogenesis of seedling; Hormonal control of seedling growth & control.

Shoot Development: Organization of shoot apical meristem (SAM); Cytological and molecular analysis of SAM; regulation of cell fate in meristem; tissue differentiation in the shoot.

Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata &trichomes) and mesophyll.

Root Development: Organization of root apical meristem (RAM); vascular tissue differentiation; lateral root hairs; root microbe interactions. Phytohormones: Classification, chemical nature and their role in plant development

Module II	**Plant Development and reproduction**	**15 hrs**

Flower Development: Physiology of flowering, florigen concept and photoperiodism, Genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Antirrhinum*.

Pollination mechanisms and vectors.Types of pollination, dispersal agencies.

Male Gametophyte: Structure of anther, microsporogenesis, tapetum; pollen development and gene expression; male sterility; sperm dimorphism; pollen germination; pollen tube growth and guidance.

Female Gametophyte: Ovule types; megasporogenesis; organization of embryo sac; types of embryo sacs, the structure of polygonum embryo sac cells.

Module III	Reproduction	15 hrs

Pollen-pistil interaction, self-incompatibility and fertilization; Structure of the pistil; pollen-stigma interactions, double fertilization; *in vitro* fertilization.Seed Development and fruit growth; Endosperm development; embryogenesis; ultrastructure and nuclear cytology; storage proteins of endosperm and embryo; Polyembryony; Apomixis; embryo. Fruit development and growth Latent life: Dormancy; Importance and types of dormancy; seed dormancy; overcoming seed dormancy; breaking of seed dormancy, and bud dormancy.
Senescence and Programmed Cell Death (PCD): Basic concepts; types of cell death, PCD in life cycle of plants; metabolic changes associated with senescence and its regulations; influence of hormones and environmental factors on senescence.

Module IV	Phytochemistry	15 hrs

A) Primary and secondary metabolites: types
B) Structure, classification and function of secondary metabolites: Phenolics, flavonoids, alkaloids, and terpenoids
C) General techniques involved in biosynthetic studies and a brief introduction to the biogenesis of secondary metabolites
D) Factors affecting secondary metabolites in medicinal plants: genotypes, plant growth regulators, elicitors, stress
E) Methods of extraction of secondary metabolites

Practical topics	Practicals based on paper-Plant development, reproduction and phytochemistry

Any 16

1. Tissue systems, meristem, vascular and cork cambium.
2. Internal structure of root, stem and leaf (dicot and monocot), advanced secondary growth in dicot stem and root.
3. Anomalies in primary and secondary structure of stem.
4. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
5. Study of cytohistological zonation in the shoot apical meristem (SAM) in sections and double-stained permanent slides of a suitable plant such as *Coleus*, *Kalanchoe*, and Tobacco.
6. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
7. Examination of rosette plants (*Launaea*, *Mollugo*, *Raphanus*, *Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.
8. Microscopic examination of sections of leaves such as *Cleome*, *Nerium,* Maize and Wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the C3 and C4 leaf anatomy of plants.
9. Study of epidermal peels of leaves such as *Coccinia*, *Gaillardia*, *Tradescantia*, *Thunbergia*, etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.
10. Study of whole roots in monocots and dicots. Examination of L.S. of root from permanent preparation to understand the organization of root apical meristem and its derivatives (maize, aerial roots of banyan, *Pistia*, *Jussieua* etc.).
11. Origin of lateral roots.
12. Study of leguminous roots with different types of nodules.
13. Study of microsporogenesis and gametogenesis in sections of anthers.

14. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (Maize, Grasses, *Crotalaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanummelongena*, etc.)
15. Tests for pollen viability using stains and *invitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
16. Estimating percentage and average pollen tube length *in vitro*.
17. Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic types of embryo sac development through examination of permanent stained serial sections.
18. Field study of several types of flower with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
19. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self-compatible and obligate outcrossing systems.
20. Study of cleistogamous flowers and their adaptations.
21. Study of nuclear and cellular endosperm through dissections and staining.
22. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygiumcumini*) etc. by dissections.
23. Study of seed dormancy and methods to break dormancy.
24. To extract plant material by hot and cold treatment
25. Estimation of Alkaloids, Phenolics, and Flavonoids by Spectrophotometric methods.
26. Separation of secondary metabolites (Alkaloids,Phenolics) by Thin Layer Chromatography.

Suggested Readings:

1. Berg, L.(2009). A Textbook of Botany: Cengage Learning India Pvt Ltd.
2. Jacobs, W.P. (1979). Plant Hormones and Plant Development: Cambridge university, London.
3. Lack., A.J. & Evans, D.E. (2015). Plant Biology: Viva Book Private Ltd, New Delhi.
4. Leopolo., C.&Emam, K.(1975). Plant Growth and Development: Tata McGraw Hill Publishing Company, Delhi.
5. Maheshwari, P. (2012). The Embryology of Angiosperm: Tata McGraw Hill Publishing House, Private, Limited, Delhi.
6. Mishra, S. (2011). Plant Hormones: Discovery Publishing house Pvt Limited, New Delhi.
7. Regland, A. &Armugam, N.(2014). Plant Function: Saras Publication, Nagarcoil.
8. Pandey&Chadha (2004). Plant Anatomy & Embryology: Vikas Publishing House Private, Ltd.Delhi.
9. Sharma., H.P. (2009). Plant Embryology: Narosa Publishing House Private Ltd.Delhi.
10. Vertpoorte R &Alfermann A.W. (2000) Metabolic engineering of Plant Secondary Metabolism. Kluwer Academic Publisher, Dordrecht, The Netherlands.
11. Buchanan, B.B., Gruissem, W. and Jones, R. L. Biochemistry and Molecular Biology of Plants.
12. Taiz., L. &Zeiger, E. (2018).Fundamentals of Plant Physiology :Sinauer Associates Inc.
13. Haborne, J.B.. (1984). Phytochemical methods.Second Edition, Springer
14. Bhojwani and Bhatnagar. (2014). Embryology of Angiosperm.

Suggested URLs/Websites:

- https://www.bionity.com/en/encyclopedia/The_ABC_Model_of_Flower_Development.html
- https://authors.library.caltech.edu/36184/1/4095.full.pdf
- https://www.cell.com/current-biology/pdf/S0960-9822(17)30343-3.pdf
- https://www.narajolerajcollege.ac.in/document/sub_page/20210313_082628.pdf

Master of Science (Botany) Semester II	
Course Code	**PG-BOT (06)-S2-T3**
Course Name	Cell, Molecular Biology- I & Data Collection, Documentation & Photography
Course Credit	04
Course Working Hours	**60 Hrs**
Course Structure	Theory and Practicals

Courseobjectives: This course aims to prepare basics of cell structure in relation to functions and provide cellular and molecular events in response to various stresses in plants.

CourseLearningOutcomes:

CO1: Students will be able to explain cell membrane features, transport mechanisms and structure and function of plasmodesmata.

CO2: Students will elucidate cytoskeleton, microtubules, microfilaments and intermediate filaments and their role in cell division.

CO3: Students will describe ultrastructure of nucleus, forms of DNA and DNA replication.

CO4: Students will classify stress and experiments on effect of various plant stress responses and appraise the defense mechanism in plants.

CO5: Students will manage data collection, documentation and understand field photography through practice.

Module I	**Membrane transport, cell membrane and cell wall**	**15 hrs**

Cell wall: Structure; function; biogenesis and growth.

Plasma membrane: Membrane architecture (fluid mosaic model); sites for ATPases; membrane transport- ion carriers, channels, pumps and aquaporins; receptors; Plasmodesmata: Structure, role in the movement of molecules and macromolecules; comparison with gap junction.

Module II	**Nucleus and cytoskeleton**	**15 hrs**

Cell shape and motility: The cytoskeleton; organization and role of microfilaments, intermediate filaments and microtubules; motor movements, implications in cell division, flagellar& other movements; Nucleus: Ultrastructure, nuclear pores, nucleolus, DNA structure A, B and Z forms, replication in prokaryotic and eukaryotic cells, DNA replication proteins.

Module III	**Stress Physiology of Plants**	**15 hrs**

Stress biology: Definition and classification of stress.

Biotic stress: Plant defense mechanism (passive and active); HR and SAR; modulation of plant metabolism in response to biotic stress: early and late response; production of ROS, induction of enzymes; PR proteins; R-genes.

Abiotic stress: Effect of water, temperature, salt and light stress on plants; developmental and physiological mechanisms protecting plants against environmental extremes.

Module IV	**Data collection, documentation and Photography**	**15 hrs**

Maintaining a laboratory record; Tabulation and generation of graphs. Application of scale bars in research photography. The art of field photography - Types of camera and lenses. Basic concepts of Photography (Exposure, Aperture, Shutter speed, ISO, exposure triangle,

depth of field focal length, sensor size)

Practical topics	Practical based on paper-Cell, Molecular Biology- I & Data Collection, Documentation & Photography

1. To study salivary gland chromosomes of *Chironomus* and *Drosophila*.
2. To isolate bacterial and plant DNA and quantify them by spectrophotometric method.
3. To demonstrate the semi-permeability of the plasma membrane.
4. To demonstrate different components of cytoskeleton in the suitable material.
5. To perform flagellar staining.
6. Isolation of DNA and preparation of Cot-curve.
7. Demonstration of vital structure and functions of cell.
8. To study the activity of PAL in the seedlings challenged with elicitors.
9. To study the induction of antioxidant enzymes in the seedlings challenged with elicitors.
10. To study the effect of water stress on the seedling growth and its chlorophyll content.
11. To study the effect of temperature stress on the seedling growth and its chlorophyll content.
12. To study the effect of salt stress on the seedling growth and its chlorophyll content.
13. To study tabulation & generation of graphs.
14. To know the imaging of tissue specimens and application of scale bars.
15. To study the art of field photography.

SuggestedReadings:

1. Armugum N. Cell Biology & Molecular biology. SarasPublication.Nagercoil, 2010.
2. Devasena T. Cell Biology. Oxford University Press, New Delhi, 2015.
3. Dnyansagar V.R. Cell Biology & Genetics. Dattson, Nagpur, 2010.
4. Gupta P.K. Cell and Molecular biology. 4thedt. Rastogi Publication, 2015
5. Kumar H.D. Molecular Biology.Vikas Publishing House.Pvt. Ltd. Noida, 2009.
6. Malcinski G.M. Essentials of Molecular biology 4th edt. Narosa Publishing House, New Delhi, 2005.
7. Pal J.&Ghaskadbi S. Fundamentals of Molecular Biology. Oxford University Press, New Delhi, 2009.
8. Paolella P. Introduction to Molecular Biology. Mc. Graw.Hill.New York. 2010.
9. Rastogi V. Principles of Molecular Biology. Scientific International Pvt. Ltd.New Delhi, 2016.
10. Upadhyay A. &Upadhyay K. Basic Molecular Biology. Himalaya Publishing House, Mumbai, 2017.
11. Verma P.S. &Agarwal V.K. Cell biology, Genetics, Molecular biology, Evolution & Ecology, S. Chand & Company limited , New Delhi, 2019.
12. Scott Kelby (2006). The Digital Photography Book.Peachpit Press.
13. Bruce Barnbaum. (2017). The Art of Photography: A Personal Approach to Artistic Expression. Second Edition.Rocky Nook.
14. Johnson C A (2010). Science for the curious photographer: An Introduction to the Science of Photography. Routeldge-Taylor and Francis, NY.

From Reference Section:

15. Bolsover S.R., Shephard E.A. , White H.A., Hyames J.S. Cell Biology – A short course.John wiley& Sons. Inc. Publication, New Jersey, 2011.
16. Buchanan, B.B., Gruissem, W. and Jones, R. L. Biochemistry and Molecular Biology of Plants.
17. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8Ed. B. I. Waverly Pvt.Ltd., New Delhi.
18. Debnath M. Molecular cell biology.Vol. I. Pointer Publishers, Jaipur, 2008.
19. Gurumani N. Research Methodology for biological sciences. MJP Publishers, Chennai, 2006.

20. Holmes D, Moody P., Dine D. Research methods for the biosciences. Oxford University Press, New York, 2006.
21. Karp G. Cell & Molecular biology-Concepts & Experiments. John Willey & Sons.Pvt. Ltd. Hoboken, 2008.
22. Khan N.A. & Singh S. Abiotic stress & plant responses. I.K. International Publishing House Pvt. Ltd. New Delhi, 2016.
23. Lodish, Berk, Krieger, Scott, Bretscher, Ploegh, Matsudaira .Molecular Cell Biology Edi. W.H. Freeman and Co., New York, USA Plants. American Soc. Of Plant Physiologists, Maryland, USA. 2000.
24. Meyers R.A. Molecular Biology & Biotechnology-A comprehensive Desk Performances. Wiley
India Pvt. Ltd. New Delhi, 2011.
25. Plopper G. Principles of cell biology. Jones & Bartlett learning, Barington, USA.2013.
26. Powar C.B. Molecular biology. Himalaya Publishing House Pvt. Ltd. Mumbai, 2013.
27. Tuteja N. &Sarvajeet G. Abiotic stress response in plants Edi. Wiley-VCH, Germany, 2016.
28. Weaver R.F. Molecular Biology (5thedt.). Mc. Graw.Hill.New York. 2008.

Suggested URLs/Websites:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=35
- http://www.dspmuranchi.ac.in/pdf/Blog/Classification_and_Tabulation_of_Data_1..pdf
- http://abacus.bates.edu/~ganderso/biology/resources/Lab_notebook_guidelines_DR_Caprette.pdf
- http://home.sandiego.edu/~ekim/e171f00/reports.pdf
- https://www.researchgate.net/publication/335652047 Writing References

Master of Science (Botany)	Semester II
Course Code	**PG-BOT (06)-S2-T4**
Course Name	Angiosperms-I, Ethnobotany& Scientific Writing and Its Presentation
Course Credit	**04**
Course working Hours	60 Hrs
Course Structure	**Theory and Practicals**

Course objectives: This course aims to introduce principles of angiosperm morphology, species concept, evolutionary inferences of important morphological characters and biodiversity assessments.

Course Learning Outcomes:

CO1: Students will be able to explain angiosperm morphology, floral organs and their evolutionary significance.

CO2: Students will construct hierarchy in taxonomy, understand species and taxon concept with the help of qualitative and quantitative characters.

CO4: Students will evaluate herbaria, monographs, biochemical and molecular tools for plant identification and diversity assessment.

CO5: Students will utilize various norms of scientific writing, presentation methods and scientific writing ethical practices.

Module I	**Angiosperm Morphology**	**15 hrs**

Angiosperm Morphology, structural units and floral symmetry, dicot and monocot flower; structure, diversity origin and evolution of stamen, carpels; placentation types and evolution.Floral adaptation to different pollinators.

Module II	**Angiosperm**	**15 hrs**

Angiosperm Taxonomy: Relative merits and demerits of major systems of classifications. Taxonomic structure: taxonomic hierarchy, concept of taxa, concept of species, concept of genus and family; Taxonomic character: HETEROBATHMY, ANALYTIC versus synthetic character, qualitative versus quantitative characters.

Taxonomic tools: herbarium, floras, monographs, botanical gardens, biochemical and molecular techniques, computers and GIS.

Module III	**Biosystematics &Ethnobotany**	**15 hrs**

Biosystematics: The population concept phenotypic plasticity, biosystematic categories, methods of biosystematics studies. Numerical taxonomy: principles, aims and objectives, cladistics in taxonomy, polarity of characters, homology, homoplasy, monophyly, polyphyly.

Plant nomenclature: Salient features of ICBN.

Ethnobotany: Definition; scope and significance; Sacred groves and their role in conservation.

Module IV	Scientific Writing and Its Presentation	15 hrs

Numbers, units, abbreviations and nomenclature used in scientific writing.Writing references.Powerpoint presentation.Poster presentation.Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practical topics	Practicals based on paper - Cytogenetics and Cell/Tissue structure methodology

1. To study the floral symmetry in various taxa.
2. To study and work out the differences in dicot and monocot plants
3. To study the variation of stamens and carpels.
4. To study placentation types in various taxa.
5. To study the floral adaptations for pollination.
6. To prepare plant specimens for deposits as herbarium vouchers and understand use of herbarium in botanical research.
7. To understand the inventory of plants using plant floras, monographs, periodicals, and e-floras or websites and use them for plant identification
8. To study basics of GIS in plant taxonomy and species distribution (demonstration)
9. To study local wild plants with ethnobotanical significance
10. To prepare a cladogram on the basis of various morphological features of the species belonging to a genus.
11. To understand and prepare reference list (e.g. Research papers, Reference books, websites, Ph.D./M. Sc. Thesis & research reports)
12. To write and understand units, abbreviations and nomenclature used in scientific writing and prepare presentations in poster and PowerPoint templates.
13. To prepare the scientific review article.

Suggested Readings:

1.Mondal A.K. Advanced plant taxonomy. New Central Book Agency (P)Ltd. Kolkata, 2005.
2.Pandey B.P. A textbook of Botany-Angiosperms.S.Chand& Company pvt.Ltd.New Delhi, 2015.
3.Saxena N.B. and Saxena S. Plant Taxonomy.PragatiPrakashan, Meerut, 2014.
4.Sharma O.P. Plant taxonomy. Tata McGraw Hill Education Pvt. Ltd., 2009.
5.Daniel, M. Taxonomy Evolution at work. Narosa Publishing House, Kolkata, 2009
6.Bhatacharya B. Systematics botany. Narosa Publishing House, Kolkata, 2005
7.Dahiya B. Systematics Botany.Kalyani Publishers, New Delhi, 1979
8.Nair R. Taxonomy of Angiosperms. A.P.H. Publishing Corporation, New Delhi, 2010
9.Pandey S.N. and Misra S.P. Taxonomy of Angiosperms. Ane Book Pvt. Ltd. New Delhi, 2008.
10.Kothar C.R. and Garg G. Research Methodology-Methods &Techniques(3rdedt.). New Age International Publishers, 2014.
11.Khanna K. Fundamentals of Research Methodology. Himalaya Publishing House, Mumbai, 2015

Suggested URLs/Websites:

- http://www.mobot.org/MOBOT/research/APweb/
- http://lifeofplant.blogspot.com/2011/05/cladistics.html

- http://sanjeetbiotech.blogspot.com/2013/02/homology-and-homoplasy-in-plant-taxonomy.html
- https://www.deshbandhucollege.ac.in/pdf/resources/1585201567_BT(H)-IV-Plant_SystematicsPhlogeny-2.pdf
- https://www.researchgate.net/publication/302584582_The_Nuts_and_Bolts_Numbers_Units_Dates_Abbreviations_Nomenclature
- https://www.researchgate.net/publication/320557873_ETHICS_IN_SCIENTIFIC_WRITING
- https://www.researchgate.net/publication/230646373_Citation_Index_and_Impact_factor
- https://www.sciencedirect.com/science/article/pii/S2049080116301303
- https://www.brown.edu/academics/medical/sites/brown.edu.academics.medical/files/uploads/Instructions%20for%20Creating%20a%20Poster%20in%20PowerPoint.pdf
- https://www.researchgate.net/publication/230646373
- https://guides.library.uq.edu.au/referencing

Template of practical examination

PRACTICAL III

	Time : 6 Hours	**Full marks : 100**
Q. 1	To perform the given physiological experiment A and report the findings	10
Q. 2	To quantify the given metabolite in the given sample B	5
Q. 3	To study the cytohistological zonation in SAM/RAM of given material C	10
Q. 4	To perform the given exercise based on plant development D	10
Q. 5	Write a note on given stage of micro- or megasporogenesis E	10
Q. 6	Spotting: F(Physiology), G (Plant development), H (Reproduction), I (Analytical Pharmacognosy), J (Phytochemistry)	20
Q. 7	Viva-voce	20
Q. 8	Practical Record and field study report.	15

PRACTICAL IV

Time : 6 Hours		Full marks : 100
Q. 1	One experiment from paper VII A	15
Q. 2	One experiment from paper VII B	10
Q. 3	One experiment from paper VIII C	15
Q. 4	One experiment from paper VIII D	10
Q. 5	Spotting- E (paper VII), F(Paper VII), G(Paper VII), H(Paper VII) I(Data generation & Photography), J(Scientific Writing & Presentation)	15
Q. 6	Viva-voce	20
Q. 7	Practical Record and field study report/ diary	15

Master of Science (Botany)	Semester III
Course Code	**PG-BOT (06)-S3-T1**
Course Name	Plant Ecology, Conservation Biology and Herbal Cosmetics & Medicines
Course Credit	04
Course Working hours	**60 hrs**
Course Structure	Theory and Practicals

Course objectives: The main objective of the course is to introduce the students to the concepts and principles of community ecology, conservation and applications of these concepts to solve ecological challenges.

Course Learning Outcomes:

CO1: Students will be able to describe and compose concept of community, ecological niche and interspecific interactions of plant as individuals and as community.

CO2: Students will perceive mechanisms of factors controlling primary production and litter fall decomposition. Students will prepare and assess ecological impact assessment and ecology of plant invasion.

CO3: Students will explain and demonstrate importance of botanical garden, seed banks in conservation of plants and understand structures of sanctuaries, biosphere reserves and other types of protected areas.

CO4: Students will analyze and categorize carbohydrate, lipid and nitrogen and amino acid metabolisms.

CO5: Students will assess working principles, methods of herbal extractions and preparations. Students will learn statistical methods.

Course Content:

Module I	**Community Ecology**	**15 hrs**

Vegetation organization: Concepts of community and continuum, analysis of communities (analytical and synthetic characters): interspecific associations, concept of ecological niche. Vegetation development: Temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models).

Community function- Dynamics and succession, laboratory model, trends in succession, climax concept, General introduction to autecology.

Module II	**Ecosystem ecology**	**15 hrs**

Ecosystem organization: Structure and functions; primary production (methods of measurement, global pattern, controlling factors); ecological efficiencies); litter fall and decomposition (mechanism, substrate quality and climatic factors); Nutrient budget in forest and aquatic ecosystem.

Ecosystem stability: Concept (resistance and resilence); Ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; environmental impact assessment; ecosystem restoration; Ecological management: Concepts; sustainable development; sustainability indicators.

Module III	**Ecosystem Conservation**	**15 hrs**

IUCN- General account, categories, Commissions, role in conservation; Red Data Book

Protected areas- Sanctuaries, National parks, Biosphere reserves; Wetlands and Mangroves Coral Reefs- Types, importance, artificial reefs, conservation measures; Botanical gardens,Seed Banks; *In-vitro* repositories; Cryobanks

Module IV	**Analytical Pharmacognosy and biostatistics**	**15 hrs**

Herbal Cosmetics & Medicines

Methods of Herbal extraction:- Maceration, digestion, Decoction, extracts and tinctures. Herbal Preparations: Churna, Asava, Arishta Products & uses of Aloe, Amla, Adathoda, Neem, Rose Turmeric, Ginger.

Descriptive statistics- Mean, median, mode, variance, standard deviation, coefficient of variation

Inferential statistics- comparing two treatment means using student t test, chi-square test, correlation, ANOVA

Practical topics	**Practicals based on theory paper Plant Ecology, Conservation Biology and Herbal Cosmetics & Medicines**

Based on Biostatistics-

1. Calculate mean, variance, standard deviation and coefficient of variation for comparing two means related to given ecological data.
2. Calculate mean, variance, and to use t-test for comparing two means related to given ecological data.
3. To find out association between important grassland species from the given data using chi-square test.
4. To find out relationship between two ecological variables using correlation analysis.
5. To perform the one-way ANOVA from the given data.

Based on Ecology-

6. A trip to the grass land/ forest/ water body to get acquainted with their plant species.
7. Distribution pattern of different plant species determined by Quadrat/Transect/ Point centered Quarter methods.
8. To determine minimum size and number of quadrats required to study grassland.
9. Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover, dominance, Abundance and IVI.
10. To determine diversity indices (Shanon-Weiner, species richness, B-diversity) from given data.
11. To estimate DO content in the eutrophic and oligotrophic water samples by azide modification of Winklers method.
12. To determine gross and net phytoplankton productivity by light and dark bottle method.
13. To estimate chlorophyll content in SO_2 fumigated and unfumigated leaves.
14. Analysis of soils of two different areas i.e. cropland and forest/ grassland for certain nutrients, CO_3, NO_3, Base deficiency.
15. To study ecological adaptations of the given plants

Based on Herbal Cosmetics & Medicines-

16. Identification of useful herbal plants.
17. To study different methods of herbal extractions.
18. To prepare different products. (Churna, Asava, Arishta)

Suggested Readings

1. Drummond J.M.F. (1990). Ecology and plant diversities. Agro Botanical Publishers (India),Bikaner

2. Leach William. (1963). Plant ecology. Methuen & Co. Ltd.,London.

3. Singh, J.S., Singh, S.P. & Gupta , S.R. (2014). Ecology, Environment Science & Conservation. S. Chand & Company pvt. Ltd. New Delhi.

4. Shukla, R.S. & Chandel, P.S. (2004).A textbook of Plant Ecology. S. Chand & Company pvt. Ltd. New Delhi.

5. Hussain Iqbal. (2008). Textbook of Plant Ecology. Oxford Book Company. Jaipur.
6. Nadkarni, K.M. (2001). Indian plants and drugs with their medicinal properties and uses. Asiatic Publishing House.Delhi.
7. Jain, S.K. (1968).Medicinal plants. National Book Trust, India. New Delhi.
8. Kumar, N.C..(2004). An introduction to medicinal botany and pharmacognosy. Emkay Publication, Delhi.
9. E. John Jothi Prakash.(2002). Medical Botany & Pharmacognosy. JPR Publication, Vaillioor.
10. Kokate, C.K., Purohit, A.P. & Gokhale, S.B. (2019).6th Edt. Pharmacognosy. Nirali Publication, Pune.
11. Subrahmanyam, N.S. & Sambamurty, A. (2006). 2nd Edt. Ecology. Narosa Publishing House, Kolkata.
12. Bhandari Ramesh. (2013). Studies on Medicinal plants & Herbs – Indian subcontinent context. Cyber Tech. Publication. New Delhi.
13. Bawa K.S. & Primack, R.B. (2004).Conservation Biology – A primer for South Asia. Meera Anna Oammen, Universities Pvt. Ltd. Hyderabad.
14. Joshi, P.C. & Joshi, N.P.(2005).A textbook of ecology & environment. Himalaya Publishing House, Mumbai.
15. Arora, M.P. (2004). Ecology. Himalaya Publishing House, Mumbai.
16. Arora, P.N. & Malhar, P.K. (2006). Biostatics. Himalaya Publishing House, Mumbai.

Suggested URLs/Websites:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2816487/
- https://www.scribd.com/document/408520763/Indian-Systems-of-Medicine
- http://nopr.niscair.res.in/bitstream/123456789/8116/1/NPR%204%284%29%20306-314.pdf
- https://www.scribd.com/document/386191833/Herbal-Cosmetics-pdf
- https://www.researchgate.net/publication/276889738_Herbal_Cosmetics_and_Cosmeceuticals_An_Overview
- http://admin.indiaenvironmentportal.org.in/reports-documents/protection-development-maintenance-and-research-biosphere-reserves-india

Master of Science (Botany)	Semester III
Course Code	**PG-BOT (06)-S3-T2**
Course Name	Angiosperms-II and Plant Nursery Management
Course Credit	04
Course Working Hours	**60 hrs**
Course structure	Theory and Practicals

Course objectives: This course aims to prepare the students to the advanced concepts and principles of taxonomy, endemism and biodiversity, important families of flowering plants, their classification and their current status as per angiosperm phylogeny.

Course Learning Outcomes:

CO1: Students will be able to understand salient features of various plant families,

evolutionary inference of various morphological characters.
CO2: Students will describe outline of recent classification system and their significance and limitations.
CO3: Students will understand biodiversity assessment and importance of local plant diversity.
CO4: Students will understand basics of plant nursery management and utilize various propagation methods to multiply plants.

Course Content:

Module I	**Angiosperms Families-I**	**15 hrs**

General account, distinguished characters, floral variation and evolution, affinities of:- Magnolidae, Hamamelidae, Dilleniidae, Rosidae, Asteridae, circumscription as per Cronquist, 1968. Salient features and outline of APG-III system of classification

Module II	**Angiosperms Families-II**	**15 hrs**

General account, distinguished characters, floral variation and evolution affinities of:- Alismatidae, Commelinidae, Aracidae, Lilidae; Interesting features and systematic position of Cucurbitaceae, Cactaceae, Asteraceae, Amentiferae, Lemnaceae, Palmae, Orchidaceae. Evolutionary trends in Angiosperms with special reference to vegetative, floral, anatomical, and chemical characters.

Module III	**Biodiversity**	**15 hrs**

IUCN categories of threat, distribution and global pattern of biodiversity.
Biological diversity concept and levels, role of biodiversity in ecosystem functions and stability, Endemism, hotspots and hottest hotspots, invasions and introductions, local plant diversities and its socioeconomic importance.

Module IV	**Plant Nursery Management**	**15 hrs**

Nursery:- Concept, types & infrastructure requirements
Seed propagation:- Germination, Production, Collection, Storage & testing of seeds
Vegetative Propagation:- Natural and Artificial (Cutting, budding, grafting and layering)
Hydroponics: Method of soil less cultivation, media, Different techniques, Advantages and disadvantages of hydroponics, Application of hydroponics in agriculture.

Practical topics	**Practicals based on paper- Angiosperms-II and Plant Nursery Management**

Practicals based on Angiosperm taxonomy:
1. Description of specimens from representative, locally available families.
2. Description of a species based on various specimens to study intra specific variation: collective exercise.
3. Description of various species of a genus, location of key characters and preparation keys at generic level.
4. Location of key characters and use of keys at family level.
5. Field trips within and around the campus; compilation of field notes and preparation

herbarium sheets of such plants, wild or cultivated as are abundant.
6. Training in using floras herbaria for identification of specimens described in the class.
7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
8. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.

Practicals based on Plant Nursery Management

9. To study effect of biotic and biotic factors on seed germination of tomato and groundnut.
10. To study factors affecting vegetative propagation (rooting and new shoot formation) by cutting of plant species (Duranta plumeri and Hibiscus, rosa-sinensis).
11. To study T-shaped budding of rose plants.
12. Study of Growing media, different techniques and suitable condition for hydroponics system

Suggested Readings

Adriance Guy W. (1955). Propagation of horticultural plants. McGraw-Hill Book Co.,New York

Bhattacharya, B. (2005). A Textbook of Systematic Botany. Narosa Publishing House Pvt. Ltd, Delhi.
Cronquist, A. (1968). A Textbook of the Evolution and Classification of Flowering Plants. Thomos Nelson and Sons Ltd, Britain.
Daniel,M.(2009). Textbook of Taxonomy evolution at work. Narosa Publishing House Pvt. Ltd, Delhi.
Hartmann and Kester's. (2001). Plant Propagation Principal and Practices. Prentice Hall of India Private Limited, New Delhi.
Kochar,S.L. (2009). Economic Botany. Macmillan Publisher Pvt. Ltd. New Delhi, India.
Mascarenhas A.F. (1993). Test tube forests. Publications & Information Directorate (CSIR),New Delhi.
Mondal,A.K.(2014). A Textbook of Advance Plant Taxonomy. New Central Book Agency,Pvt,Ltd. Howrah.
Nair, R. (2010). Taxonomy Of Angiosperms. A.P.H. Publishing Corporation, New Delhi.
Nanda K.K. (1985). Vegetative propagation of plants. Kalyani Publishers,New Delhi
Pandey, S.N & Misra, S.P.(2014). Taxonomy of Angiosperms. Ane Book Pvt Ltd. New Delhi.
Pandey,B.P.(2015). A Textbook of Botany Angiosperms. Nirja Publishers & Printers Pvt:Ltd & S. Chand & Company Pvt: Ltd., Ramnagar, New delhi.
Pradhan, A. (2013). Monocot Weeds. Salasar Imaging System, Delhi.
Randhawa & Mukhopadhyay. (2015). A Textbook Of Floriculture In India. Allied Publisher Private Limited, New Delhi.
Saxsena & Saxena.(2014). Textbook of Plant Taxonomy. Pragati Prakashan Educational Publishers, Meerut.
Sharma, O.P. (2009). Plant Taxonomy. McGraw-Hill Education (India) Private Limited,Tamilnadu, India.
Singh, Pande & Jain. (2011). A Textbook of Botany Angiosperms. Rastogi Publications, Meerut, India.

Suggested URLs/Websites:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
- http://www.surendranathcollege.org/new/upload/KOUSIK_GHOSH2020-04-05APG%20III%20Classification%20COMPILED.pdf
- http://francescofiume.altervista.org/taxa/APG.pdf
- http://www.mobot.org/MOBOT/Research/APweb/welcome.html

Master of Science (Botany) Semester II	
Course Code	**PG-BOT (06)-S3-T3-E1**
Course Name	Molecular Biology & Plant Biotechnology
Course Credit	04
Course Working Hours	**60 Hrs**
Course Structure	Theory and Practicals

Course objectives: This course aims to prepare students with an understanding of principles and techniques of plant tissue culture, recombinant DNA technology concepts and applications and basics of bioinformatics.

Course Learning Outcomes:

CO1: Students will be able to explain principles and techniques of plant tissue culture.
CO2: Students will elucidate principles, tools and techniques of gene cloning process.
CO3: Students will describe and compare various cloning vectors and understand their role in cloning process.
CO4: Students will understand basics of bioinformatics.

Module I	**Plant cell and tissue culture**	**15 hrs**

Basic concept of cellular differentiation (dedifferentiation, undifferentiation, and redifferentiation), totipotency, Application of plant cell and tissue culture, Micropropagation- Steps, factors affecting micropropagation, Direct and indirect organogenesis, Adventitious embryogenesis, Somatic embryogenesis, factors affecting somatic embryogenesis, applications of SE, Synthetic seeds and preparation of synthetic seeds, Application of synthetic seeds

Module II	**rDNA technology**	**15 hrs**

a. Tools of rDNA technology: DNA manipulation enzymes- nucleases, polymerases, ligases, kinases, and phosphatase, Methods of gene isolation.
b. Molecular probing- Recombinant DNA libraries (gDNA and cDNA), oligonucleotide probes, nucleic acid hybridization (Southern, Northern, dot-blot, slot blot), antibodies as probe for protein detection (Western blotting, Immunoprecipitation, Southwestern screening), Polymerase Chain reaction- working principle, technique and PCR modifications, Applications of PCR in plant molecular biology

Module III	**Cloning vector**	**15 hrs**

Vectors for prokaryotes and eukaryotes, ligation process, plasmids, cosmids, bacteriophages, Insertion and replacement vectors, TAC, BAC.
Introduction of foreign DNA into host cell- Transformation, transfection, transgenesis
Isolation of genes or protein products from clones, Expression vectors- characteristics, Vectors producing fusion proteins

Module IV	**Sequence alignment and phylogenetic trees**	**15 hrs**

Sequence analysis- concept and tools, similarity searches: BLAST, FASTA, scoring matrices: PAM, pairwise sequence analysis: Needleman and Wunch, pairwise and multiple sequence alignment (dot matrix method), local and global sequence alignment
Phylogenetic trees: Concept, types of trees, algorithm types- UPGMA, NJ, and MP.

Practical topics	Practical based on paper-Molecular Biology & Plant Biotechnology

Group A

1. To design PCR primers to isolate the given gene for cloning it in the given vector.
2. To isolate plant genomic DNA amplify the specific regions of nrDNA by PCR

3. To find the sequences of a given protein in the protein database
4. To work out the sequence from given autoradiogram and to identify it from GeneBank by BLAST method.
5. To download the DNA sequences from databases and generate pairwise and multiple sequence alignment.
6. To download the protein sequences from databases and generate pairwise and multiple sequence alignment.
7. To generate phylogenetic tree using given DNA and protein sequences.
8. To predict a protein from given sequence by using online tools from NCBI.

Group B

11.To demonstrate Agrobacterium tumefaciens mediated gene transfer in a suitable plant.
12.To raise the suspension culture using a callus and plot the growth curve.
13.To induce the secondary metabolite synthesis in suspension culture.
16.To demonstrate bacterial transformation and selection of transformed cells.
17.To perform DNA ligation and analysis of ligated DNA on agarose gel.
18.To demonstrate oganogenesis using appropriate explants.
19.To demonstrate somatic embryogenesis using appropriate explants and prepare artificial seeds.
20.To demonstrate preparation of synthetic seeds.
21.To demonstrate the anther culture.
22.To initiate micropropagation protocol of suitable plant species.

Suggested Readings

Bacevanii, A.D. & Francis Ouellette, B.F. (2006). Bioinformatics – A practical guide to the analysis of genes and proteins. Wiley India Pvt. Ltd., New Delhi.
Ghosh, Z. & Mallick, B. (2008). Bioinformatics- Principle Applications. Oxford University Press. London.
Zesk. A.M. (2008). Introduction o Bioinformatics. Oxford University Press. London.
Tandon, P. Advances in Plant tissue culture in India. Pragati Prakashan, Meerut.Co. pvt. Ltd. New Delhi.
Kumar, B. & Gautam, S. (2014). Plant tissue culture. Sonali Publication, New Delhi.
Razdan, M.K. (2016). Introduction to Plant tissue culture. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
Klug, W., Cummings, M., Spenger, C.A. & Palladino, M.A.(2016). Concepts of Genetics. Pearson Education Service Pvt. Ltd. Chennai.
Aneja, K.R. (2003). Experiments in Microbiology, Plant Pathology & Biotechnology. New Age International Publisher, New Delhi.
Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2011) Lewin's Gene X.10th edt. Jones and Bartlett Publishers, Canada.
Rastogi, S. & Pahak, N. (2016). Genetic Engineering. 7th Edt. Oxford University Press. New Delhi
Das, H.K. (2010).A text book of Biotechnology. 4th Edt. Wiley India Pvt. Ltd., New Delhi.
Kar, D. & Halder, S. (2011). Cell biology, Genetics & Molecular biology. New Central Book Agency (P)ltd. London.

Suggested URLs/Websites:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4

Master of Science (Botany)	Semester III
Course Code	**PG-BOT (06)-S3-T3-E1**
Course Name	Mycology & Plant Pathology
Course Credit	**04**
Course working Hours	60 Hrs
Course Structure	**Theory and Practicals**

Course objectives: This course aims to build understanding of students in basic concepts of medical mycology and plant mycology with more emphasis on agricultural pathogens.

Course Learning Outcomes:

CO1: Students will be able to describe different variety of fungal diversity in a different ecosystem as well as mycorrhizal diversity.

CO2: Students will understand different types of dermatophytic fungi and describing variety of antibiotics in the medical mycology.

CO4: Students will describe and understand Industrial and nonindustrial fungal metabolites.

CO5: Students will able to describe different types of methods related with mushrooms and understand their cultivation practices.

Module I	**General Microbiology**	**15 hrs**

General characters, classification, distribution and reproduction Fungal diversity in different ecosystems, Rhizosphere and phyllosphere : General concept and importance. effect of environment on fungal growth and behaviour. Kinds of mycorrhizae : Ectotrophic and endotrophic mycorhizae, their morphology and anatomy. V A- mycorrhiza. Mycorrhiza in plant growth promotion, mycorrhiza in plant disease control.

Module II	**Medical Mycology**	**15 hrs**

Medical Mycology - Dermatophytic fungi -Knowledge of common dermatophytes and human diseases caused by them viz. *Tinea pedis, Tinea capitis, Tinea barbae. Tinea, corporis* and *Tinea manuum;* Aspergillosis, fungi allergic to human beings. lndustrial Fungal Metabolites: i) Antibiotics -penicillin, Cephalosporin, Griseofulvin, Industrial production of Penicillin ii) Enzymes -. Amylase, proteases, Lipases, Pectinases, Cellulase and xylanases. iii) Organic acids -Critic acid, Gluconic acid, lactic acid, kojic acid. ltaconic acid.

Module III	**Module III: Production of Metabolites by Fungi**	**15 hrs**

Fungi as welfare to human being and non-industrial fungi i) Fungi in food processing: Soybean products, cheese, fermented milk, and other fermented foods. ii) Fungal metabolites : General account of production and application; Primary metabolites (vitamins, proteins), Secondary metabolites (antibiotics, pigments, alkaloids) iv) Fungi as food : edible mushrooms, methods of their cultivation Role of fungi in biodeterioration and Biodegradation (Cellulosic and Non-cellulosic material organic compounds) Non industrial Fungal Metabolites: i) Phytoalexins, ii) Mycotoxins

Module IV	Mushroom cultivation and Introduction to plant pathology	15 hrs

Mushroom Cultivation and Introduction to plant pathology Mushroom Cultivation: Types of Mushroom, Different cultivation practices of mushroom (Button , Milky and Oyster),Growth and stages of mushroom, Edible and poisonous mushroom, Mushroom toxins, Diseases and pests of edible mushroom, nutritive value of mushroom.

Introduction to plant pathology: Concept of disease, Koch's postulates, disease quantification, disease cycle. Enzyme, Toxin and Growth regulators.

Practical topics	Practicals based on paper - Mycology & Plant Pathology

1. Principles & working of tools, equipments and other requirements in the Mycology & PlantPathology laboratory.
2. Micrometry and measurement of organisms.
3. Sterilization Processes viz. moist heat, dry heat, chemical and radiation.
4. Drawing of Camera Lucida diagrams and knowledge of computer based photomicrographyand image processing
5. Preparation of different cultural media for cultivation of Fungi and Bacteria.
6. Monitoring and analysis of Aeromycoflora.
7. Isolation & identification of Phyllosphere mycoflora.
8. Demonstrate antifungal activities of different antibiotics and leaf, flower and root extract.
9. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.
10. Cultivation of Mushrooms.
11. Demonstration on biodegradation of organic waste.
12. Isolation of Soil fungi by soil plate (War cup) and serial dilution (Walksman) method.
13. Isolation and identification of Rizosphere mycoflora.
14. Isolation of external and internal seed borne mycoflora by blotter and Agar Plate method.Cereals, pulses, oil seeds, fruit seeds.
15. Demonstration of Koch"s Postulate.
16. Calculation of spore count using haemocytometer.
17. Qualitative estimation of enzymes – cellulases, amylases.
18. Estimation of sugars, proteins and aminoacids in fungal mycelium and culture filtrate.
19. Study of mycorrhiza (VAM)
20. Monographic study of locally available plant diseases caused by fungi (atleast 10).
21. Study of locally available crop plant diseases caused by Bacteria (Five)
22. Study of locally available plant diseases caused by viruses & Phytoplasma (Five)
23. Demonstration of morphological & physiological changes in disease plants.
24. Preparation and presentation of herbarium of pathological specimens available in theregion (Atleast 15)
25. Field visit to different localities Visit to Agriculture University, Plant Pathological researchcenters

Suggested Readings

1. Singh, H. (1983). Mushroom Growing In India. Steriling Publisher Private Limited, Bangalore.

2. Nair,L.N.(2001). Topics in Mycology and Pathology. New Central Book Agency, Kolkatta.
3. Sethi and Walia. (2011). A Textbook of Fungi & Their Allies. Macmillan publishers, New Delhi. India.
4. Aneja, K.R. (2015). Experiments in Microbiology Plant Pathology and Biotechnology. New Age International Publisher, New Delhi.6th Edition.
5. Dubey and Maheshwari. (2016). Practical Microbiology. S.Chand and Company Private Limited, New Delhi.
6. Hait, G.(2016). A Textbook of Mycology. New Central Book Agency, Kolkatta.
7. Sethi and Walia. (2011). A Textbook of Fungi & Their Allies. Macmillan publishers, New Delhi. India.
8. Singh, H. (1983). Mushroom Growing In India. Steriling Publisher Private Limited, Bangalore.

Suggested URLs/Websites:

Master of Science (Botany)	Semester III
Course Code	**PG-BOT (06)-S3-T4- SF1**
Course Name	Aesthetic Botany
Course Credit	**04**
Course working Hours	60 Hrs
Course Structure	**Theory**

Course objectives: This course aims to enhanced increased understanding of students associated with knowledge of plants with immense economic values.

Course Learning Outcomes:

CO1: Students will be able to understand basics of aesethetic plants and their phytogegraphical destribution

CO2: Students will understand construct basic knowledge of garden designs, features of gardens and planning of outdoor gardens.

CO4: Students will evaluate and understand physical factors of nursery developments and disease management of gardens and plant nurseries.

CO5: Students will understand landscaping elements and different plant types for landscape.

Module I	**General Aspect of Aesthetic plants**	**15 hrs**

Phytogeography regions of India: Climate, Vegetation and Floristic regions, Endemism; Concept of hotspots, hot spots of the world. Forest types of India

Aesthetic plants: outdoor and indoor plants

Module II	**Gardening**	**15 hrs**

Garden Design: Scope and objectives of gardening; Style of gardens (Formal, Informal); Types of gardens (English, Mughal and Japanese); Components of garden;

Planning of outdoor gardens: Small, Residential, Larger Home Garden, Roof Garden, Terrace Garden, Industrial garden, Housing complex, Indoor gardening

Garden Features and Ornamentation: Water, Garden pool, Stream, Waterfall,

Fountain, Rocks, Roads, Walks, Pavements and Steps, Walls fences and Gates, Hedges, Edges, Arches, Statues, Towers.

Module III	Module III: Floriculture	15 hrs

Nursery production and management: Scope, Site, Soil, Environment, Layout, Manure, Fertilizers, Maintenance, Garden tools, Culture and Garden calendar, Types, Nursery beds,

Pest & Disease management: Propagation of ornamental plants by seeds, bulbs, layering, cuttings, grafting, budding & tissue culture; Plant disorders including nutrition, pests and diseases, and chimaeras Ornamental ferns and their propagation; herbaceous perennials, Annuals & Biennials: Important Genera and Species, their importance in garden designs.

Module IV	Landscaping	15 hrs

Landscape Design: Definition, objectives and scope, Landscape elements of construction anddesigning of Residential, Commercial, Bungalow, Public area, Hotel, Educational Institute andreligious places

Palms and Cycas: Characteristics, propagation, culture, pest and disease,importance and uses, genera and species of palms and Cycads.

Bamboo and conifers: Genera, species and varieties; Lawns & Grasses: Planting methods, maintenance, pest management

Ornamental succulents, Cacti; Polyhouse technology: Scope and objectives of floriculture.

Suggested Readings

Kehimkar , I. Issac. (2009). Common wild flowers. Bombay Natural History Society, Oxford University Press, Chennai.
Randawa GS and Mukhodpadhyaya A (2004) Floriculture in India. Allied Publishers Pvt. Ltd
Swarup V (2003) Garden Flowers, National Book Trust, New Delhi, India
Hartman HT, Kester DE, Davis FT and Geneve RL (2002) Plant Propagation-Principles and Practices. Prentica Hall India Ltd.
Storosta, P. & Cerutti, V. (1998). Cacti.

Suggested URLs/Websites:

Master of Science (Botany)	**Semester III**
Course Code	**PG-BOT (06)-S3-Foundation Course I**
Course Name	General Botany
Course Credit	**04**
Course working Hours	60 Hrs
Course Structure	**Theory**

Course objectives: This course aims to enhanced increased understanding of knowledge of plants with immense economic values for MSc students opting non-subject centric foundation course.

Course Learning Outcomes:

CO1: Students will be able to explain angiosperm morphology and basic plant taxonomy.

CO2: Students will elaborate fundamental of biodiversity and ecotourism.

CO4: Students will utilise basic knowledge of plant resources and their use in daily life.

CO5: Students will understand ecosystem, pollution and methods of waste degradation.

Module I	**Morphology and Taxonomy**	**15 hrs**

Morphology of- Root, stem, leaf, flower and fruit.

Histology- Cell types and tissue systems in plant, specialized cells

Taxonomy- Classification system of Bentham & Hooker; General characters of- Fabaceae, Solanaceae, Verbanaceae, Liliaceae, Poaceae, Plant identification techniques

Module II	**Biodiversity & Ecotourism**	**15 hrs**

Concept of biodiversity; Types (Species, genetic, ecosystem diversity); present status in India;

Values of biodiversity; Mega-biodiversity centres; CBD- General account.

Aesthetic beauty of wild beautiful plants and their value in nature for Ecotourism point of view in various forests.

Module III	**Plant resource utilization**	**15 hrs**

Botany and uses of plants as a source of- fire wood, timber, Non-Wood forest products, cereals,

pulses, oilseeds, spices, condiments, narcotics, beverages, fodder, forage, medicine and essential oil (any three of each type).

Module IV	**Ecology & Biodegradation of waste**	**15 hrs**

Introduction, concept of ecosystem, types of ecosystems, food chain and food web.
Pollution: Sources, consequences control of soil, air and water pollution. Carbon credit.
Various methods of bio-degradation of waste materials.

Suggested Readings

Dash MC 1993.Fundamentals of Ecology. WB Saunders can Co., Philadelphia.
Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press, London.
Jones, S. B., Jr.and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw -Hill Book
Co., New York.
Khalid H and Nawaz K 2014.Introductory plant taxonomy. Kalyani Publ., New Delhi.
Kochhar PL 1986. Plant Ecology. Ratan Prakashan, Agra.
Kochhar SL 1998. Economic Botany in tropics 2e. Macmillan India Ltd., New Delhi.
Kumar HD 1994. Modern concepts of ecology. Vikas Publi. House Pvt. Ltd., New Delhi.
Sharma OP 1996 Hill‟s Economic Botany. TMH Publ. Co. Ltd., New Delhi.
Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersery.

Template of practical examination

PRACTICAL V

Time : 6 Hours		Full marks : 100
Q. 1	To perform the given ecological exercise A	15
Q.2	To solve the given statistical problem B	15
Q.3	To describe the given plant in technical language with floral formula and floral diagram C	10
Q. 4	To prepare the generic/family key D	5
Q. 5	To identify species of the given plant using Flora	5
Q. 7	Spotting- E(Paper IX), F(paper IX), G(Paper X), H(Paper X),	
	I(Herbal Cosmetics & medicines), J(Plant Nursery Management)	15
Q. 8	Viva-voce	20
Q. 9	Practical Record	15

SEMESTER III
PRACTICAL VI MYCOLOGY AND PLANT PATHOLOGY

Time: 6 Hours	Full Marks:	100
Identify giving salient characters of fungi from the given culture. (A)		10
Identification of given diseased material, their symptoms and characters. (B)		10
Effects of different concentrations of sugar solutions on the conidial germination and presentation of data on graph paper.		
		10
Drawing of camera lucida diagram of the given fungus/microorganism.		10
Demonstration of pure culture techniques /transfer techniques.		10
Spotting (two spots)		10
Practical record, Herbarium and field report		20
Viva-voce		20

PRACTICAL VI

MOLECULAR BIOLOGY AND PLANT BIOTECHNOLOGY			
Time: 6 Hours		Full Marks:	100
1	One Major Experiment from Group A		15
2	One Minor Experiment from Group A		10
3	One Major Experiment from Group B		15
4	One Minor Experiment from Group B		10
5	Identification and comments on given two spots		10
6	Practical record		20
7	Viva-voce		20

Master of Science (Botany)	**Semester IV**
Course Code	**PG-BOT (06)-S4-T1**
Course Name	**Cell and Molecular Biology-II**
Course credit	**04**
Course working hours	**60 hours**
Course structure	**Theory and Practical**

Course Objectives: The main objective of the course is to introduce the students to the concepts of the gene structure and regulation of gene expression and know the mechanism of cell cycle regulation and techniquesin cell biology

Course Learning Outcomes:

CO1: Students will be able to describe and know concept of ribosomes, steps involved in transcription and translation, and understand fine structure of gene.

CO2: Students will perceive mechanisms of factors controlling gene regulation and their types. Students will synthesis mechanisms of protein targeting and transports of proteins between organgelles.

CO3: Students will be able to understand mapping of genes through various molecular processes and know the genetic recombination at molecular level.

CO4: Students will know the regulation of cell cycle proteins, apoptosis and signal transduction mechanisms.

Course Content:

Module I	**Ribosomes and Gene structure**	**15 hrs**

Ribosomes: Structure and function

Transcription: Transcription in prokaryotic and eukaryotic cells, plant promoters, transcriptionfactors, types of RNA and their function, RNA splicing, mRNA transport

Translation: In prokaryotic and eukaryotic cells, structural levels of proteins, post-translationalmodification; structure and role of rRNA and tRNA.

Gene structure: Chemical nature & Fine structure of gene, Classical and modern concept of gene,Cis-trans test; fine structure analysis in eukaryotes; introns and their significance, RNA splicing

Module II	**Regulation of Gene & DNA damage-repair system**	**15 hrs**

Regulation of gene expression: Prokaryotes- Positive & negative control, inducible and repressible operons, lac operon, trp operon, attenuation, riboswitch; Eukaryotes- Regulation at DNA, transcription, translation & post translational level

Protein targeting and sorting: Protein glycosylation; vesicles involved in proteintransport; protein targeting to plastids, mitochondria, peroxisomes, nucleus, vacuoles; modification

during transport.

DNA damage and repair: Types of DNA damage, factors for DNA damage, Repair system: Singlebase change, direct repair, mismatch repair, SOS response.

Module III	Genome Organization & Genetic Mapping	15 hrs

Genome organization in prokaryotes and eukaryotic organelles: Phage genome, genetic recombination in phage and mapping phage genes; mapping of bacterial genes through transformation, conjugation and transduction; genome of mitochondria and chloroplast.

Genetic recombination and genetic mapping: Recombination; independent assortment and crossing over; molecular mechanism of recombination; role of RecA and RecBCD enzymes; homologous, non-homologous and site-specific recombination; chromosome mapping- linkage group.

Module IV	Cell cycle and Apoptosis	15 hrs

Cell cycle and apoptosis: Control mechanisms, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; Apoptosis and its pathway

Signal transduction: Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascades, diversity in protein kinases and phosphatases;

Techniques in cell biology: Electrophoresis, immunotechniques, FISH, GISH, confocal microscopy.

Practical	Practicals based on theory paper-Cell and Molecular Biology-II

1 Isolation and separation of plant cytosolic proteins by SDS-PAGE
2 To perform the restriction digestion of the DNA & analyse the digest over agarose gel.3 To study transformation in bacterial cells.
4. To detect the presence of specific antigen by ELISA
5. Isolation of RNA and quantification by spectrophotometric method.
6. To map the genes based on given cross-over data.
7. Gene induction: b-galactosidase assay of E coli
8. Preparation of protein sequence using mRNA and preparation of mRNA sequence from DNA sequence with manual method and bioinformatics tool.
9. Identify and download protein sequence of G-protein coupled receptors from plants and other organisms.

Suggested Readings

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell,Garland Publishing, Inc., New York.
2. Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology ofPlants. American Soc. Of Plant Physiologists, Maryland, USA.
3. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8th Ed. B. I. Waverly Pvt.Ltd., New Delhi.
4. Jones R, Ougham H, Thomas H, Waaland S 2013 The Molecular life of plants. Wiley Blackwell,USA
5. Karp, G. 1999 Cell and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc.,USA.
6. Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2 nd Edi.) Harper Collins Coll. Publisher, New York, USA.
7. Lewin, B. 2000 Gene VII Oxford Univ. press, New York.
8. Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Darnell, J. 2000 MolecularCell Biology Edi. W.H. Freeman and Co., New York, USA.

9. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.) Jones and Bartiet Pub. Inc., London.
10. Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2nd Edi.) John Wiley & Sons Inc.,USA.
11. Tamarin, R. H. 2001 Principles of Genetics 7th Edi. The McGraw-Hill Companies.
12. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.

Suggested URLs/Websites:

https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA==
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Master of Science (Botany)	**Semester IV**
Course Code	**PG-BOT (06)-S4-T2**
Course Name	**Plant Biotechnology & Bioinformatics**
Course credit	**04**
Course working hours	**60 hours**
Course structure	**Theory and Practical**

Course objectives: This course aims to prepare the students to understand the principles and techniques ofgene cloning, and basic concept of tissue culture and transgenic plants.

Course Learning Outcomes:

CO1: Students will be able to understand salient features of recombinant DNA technology, and principles of gene cloning.

CO2: Students will learn microbial genetic manipulation methods and polymerase chain reactions, and methods of sequencing.

CO3: Students will understand basics of plant tissue culture.

CO4: Students will understand basics of bioinformatics, DNA and protein databases and their applications.

Course Content:

Module I	**Recombinant DNA technology**	**15 hrs**

a. **Recombinant DNA technology**: Gene cloning- Principles and technique; vectors- types (cloning & expression; plasmid & viral) and their properties; construction of DNA libraries (gDNA and cDNA); splicing of insert into the vector; screening of DNA libraries and introduction of the recombinant DNA into the host cells.

b. **Genetic engineering of plants**: Aims, strategies for development of transgenics (with suitable examples); Agrobacterium- the natural genetic engineer; T-DNA and transposon mediated gene tagging.

Module II	**Genetic**	**15 hrs**

	Engineering	

a. **Microbial genetic manipulation**: Bacterial transformation, selection of recombinants and transformants,

b. **Genomics and proteomics**: high throughput sequencing; functional genomics; Protein profiling and its significance.

c. **DNA synthesis:** DNA sequencing; basic polymerase chain reaction and applications of PCR; DNA fingerprinting

Module III	**Plant tissue culture**	**15 hrs**

Module III Plant Tissue Culture

Plant tissue culture: Basic concepts; Principles and scope; tissue culture media; callus induction and cell suspension; aspects of morphogenesis; haploid and triploid production; production of somatic embryos; applications of plant tissue culture; protoplast isolation and culture; production of cybrids

Transgenic production: Methods to introduce gene in plants; selection of transformed plants/explants; Application of transgenic crop production.

Module IV	**Bioinformatics**	**15 hrs**

Bioinformatics: Introduction, History, Definition and applications of bioinformatics; Database: Sequences (nucleotide and amino acid); nomenclature- IUPAC symbols, nomenclature of DNA & protein sequences, Definitions, types and classification of databases- Primary Databases, Secondary databases. Applications of bioinformatics.

Practical	**Practicals based on theory paper – Plant biotechnology & Bioinformatics**

1. To study the growth characteristics of *E. coli* using plating and turbidimetric methods.
2. To isolate the plasmid from *E. coli* and quantify it with suitable method.
3. To perform restriction digestion of the given plasmid DNA and to estimate of the size of various DNA fragments.
4. To Clone the given DNA fragment in a plasmid vector.
5. To prepare competent cells from the given bacterial culture.
7. To prepare the media for plant tissue culture.
8. To surface sterilize the given seeds/explant for tissue cultural manipulation.
9. To isolate protoplast and determine its viability.
10. To workout the DNA sequence from the given autoradiogram and identify the gene using online tools.
11. To search literature database of different organisms.
12. To search the genes in the Genebank.
13. To use the various tools to retrieve information available from NCBI
14. To locate gene(s) on chromosomes for a given disease/disorder.

Suggested Readings

1. Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics, John-Wiley and Sons Publications, New York.
2. Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
3. Brown, T. A. 1999. Genomes, John Wiley &Sons (Asia) Pvt. Ltd., Singapore.
4. Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.
5. Chrispeeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture. Jones & Barlett Publishers, Boston, USA.

6. Dubey, R. C. 2014 Advanced Biotechnology. S. Chand & Co. Pvt. Ltd., New Delhi.
Glazer, A. N. and Nikaido, H. 1995. Microbial Biotechnology. W. H. Freeman & Company, NewYork, USA.
7. Gustafson, R. J. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA. Henry, R. J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London,UK.
8. Jain, S. M., Sopory, S. K. and Veilleux, R.E. 1996. In vitro Haploid Production in Higher Plants, Vols. 1-5, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
9. Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
10. Kartha, K. K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, FloridaUSA.
11. Kingsman, S. M. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford, 1998 Mount W. 2004 Bioinformatics and sequence genome analysis 2nd Edi. CBS Pub. New Delhi
12. Old, R. W. and Primrose, S. B. 1989. Principles of Genome Analysis. Blackwell Scientific Publications. Oxford, UK.
13. Primrose, S. B.1995. Principles of Genome Analysis. Blackwell Scientific Ltd., Oxford, UK.

Suggested URLs/Websites:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
- http://www.surendranathcollege.org/new/upload/KOUSIK_GHOSH2020-04-05APG%20III%20Classification%20COMPILED.pdf
- http://francescofiume.altervista.org/taxa/APG.pdf
- http://www.mobot.org/MOBOT/Research/APweb/welcome.html

Master of Science (Botany)	**Semester IV**
Course Code	**PG-BOT (06)-S4-T3-E1**
Course Name	**Molecular Biology and Plant Biotechnology**
Course credit	**04**
Course working hours	**60 hours**
Course structure	**Theory and Practical**

Course objectives: This course aims to prepare students with an understanding of principles and techniques of plant tissue culture, development of transgenic plants, their applications and DNA fingerprinting methodsand their applications.

Course Learning Outcomes:

CO1: Students will be able to explain principles and techniques of plant tissue culture.

CO2: Students will elucidate principles, tools, and techniques of transgenic developments of plants for various traits.

CO3: Students will describe and compare transgenic plants for various economically important traits.

CO4: Students will understand basics principles of DNA based markers, and their types and functional genomics approaches.

Course Content:

Module I	**Plant Cell and Tissue Culture**	**15 hrs**

Cell culture, isolation of single cell, techniques; factors affecting single cell culture, Induction of callus. Cell suspension culture: techniques and maintenance of suspension culture. Use andTypes of bioreactors for enhanced multiplication of cell suspensions
Isolation and purification of protoplast, culture of protoplast and regeneration of protoplast. Somatic Hybridization; culture and selection system for hybrids. Cybridization and production of cybrids. Role of somatic hybrids and cybrids in plant improvement,
Haploid production and its significance. Factors affecting Anther and pollen culture technique, monoploidand polyploid culture *in-vitro*.

Module II	**Transgenic plants**	**15 hrs**

Transgenic plants: Cloning vectors for higher plants; Methods for gene transfer, *Agrobacterium tumefaciens* mediated gene transfer- Basis of tumor formation, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes;
Direct DNA transfer: particle bombardment, electroporation, microinjection, liposomes, pollen transformation; PEG method; transformation of monocots; transgene stability andgene silencing; chloroplast transformation.

Module III	**Application of transformation**	**15 hrs**

a. **Applications of transformation**: Herbicide resistance; insect resistance; Bt genes, disease resistance; Nutritional quality, Intellectual property rights, hazards, and safety regulations for transgenic plants.

b. **Transgenics and molecular farming**: Production of secondary metabolites; industrial enzymes; biodegradable plastics (PHB); edible vaccines; antibody production and other important drugs.

Module IV	**DNA fingerprinting and global gene expression**	**15 hrs**

a. **DNA fingerprinting and marker assisted breeding**: DNA based markers definition and properties of molecular marker, Hybridisation based marker- RFLP and its applications, PCR-based markers: RAPDs, ISSRs, STS, SSR (microsatellites); SCAR (sequence characterized amplified regions); SSCP (single strand conformational polymorphism); AFLPs; SNPs, molecular marker assisted selection

b. **Techniques used to study gene expression at transcription level**: Northern hybridization, differential display of mRNA, ESTs, cDNA-AFLP, DNA microarrays

Suggested Readings:

1. Aneja, K.R. (2003). Experiments in Microbiology, Plant Pathology & Biotechnology. New Age International Publisher, New Delhi.
2. Bacevanii, A.D. & Francis Ouellette, B.F. (2006). Bioinformatics – A practical guide to the analysis of genes and proteins. Wiley India Pvt. Ltd., New Delhi.
3. Das, H.K. (2010).A text book of Biotechnology. 4th Edt. Wiley India Pvt. Ltd., New Delhi.
4. Ghosh, Z. & Mallick, B. (2008). Bioinformatics- Principles and Applications. Oxford University Press. London.
5. Kar, D. & Halder, S. (2011). Cell biology, Genetics & Molecular biology. New Central Book Agency (P)ltd. London.
6. Klug, W., Cummings, M., Spenger, C.A. & Palladino, M.A.(2016). Concepts of Genetics. Pearson Education Service Pvt. Ltd. Chennai.
7. Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2011) Lewin's Gene X.10th edt. Jones and Bartlett Publishers, Canada.
8. Kumar, B. & Gautam, S. (2014). Plant tissue culture. Sonali Publication, New Delhi.
9. Rastogi, S. & Pathak, N. (2016). Genetic Engineering. 7th Edt. Oxford University Press. New Delhi
10. Razdan, M.K. (2016). Introduction to Plant tissue culture. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
11. Tandon, P. Advances in Plant tissue culture in India. Pragati Prakashan, Meerut.Co. pvt. Ltd. New Delhi.
12. Zesk. A.M. (2008). Introduction o Bioinformatics. Oxford University Press. London.

Suggested URLs/Websites:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4

Master of Science (Botany)	**Semester IV**
Course Code	**PG-BOT (06)-S4-T3-E2**
Course Name	**Mycology and Plant Pathology-II**
Course credit	**04**
Course working hours	**60 hours**
Course structure	**Theory and Practical**

Course objectives: This course aims to build understanding of students in basic concepts of medicalmycology and plant mycology with more emphasis on agricultural pathogens.

Course Learning Outcomes:

CO1: Students will be able to describe history, milestones in Indian phytopathology.

CO2: Students will understand host plant-pathogen interaction, compare morphological, structural,
biochemical changes during pathogen spread, and mechanism of plant disease control.

CO3: Students will describe and know viral, bacterial, fungal and nematode induced diseases and their
control measures.

Course Content:

Module I	**Phytopathology**	**15 hrs**

History: Milestones in phytopathology with reference to India. Major epidemics and their social impacts. Historical developments of chemicals, cultural and biological protection measures; Altered metabolism of plants under biotic and abiotic stresses. Koch's Postulates Epidemiology and forecasting of plant diseases Indian Institutes and their research activities in Mycology and Plant Pathology

Module II	**Principles of Plant Pathology**	**15 hrs**

i. Principles of plant pathology-Importance, nature, classification, and general symptoms of plant diseases.
ii. Pathogenicity of microorganisms and pathogenesis.
iii. Host parasite relationship and Interaction; Signal transduction.
iv. Defense mechanism in host plants against pathogens: morphological, structural defense mechanism; Biochemical defense mechanisms role of phenolic compounds, enzymes & toxins,
v. Principles and methods of plant disease control -cultural methods, chemical methods, biological control, transgenic approach for plant disease control, integrated pest management (IPM), Biopesticides.

Module III	**Fungal diseases**	**15 hrs**

A Detailed study of the Diseases of the following crops caused by fungal pathogens with effective control measures: **Diseases of Cereals**: Seedling blight of cereals, Smut of wheat, Foot rot of wheat, Covered smut of Barley, False smut of rice, Downey mildew of jowar, greenear disease of Bajra, Ergot of Bajra, Downey mildew of maize;

Diseases of Vegetable crops with special reference to the important diseases of the following: Chili, Brinjal, Tomato, Onion, Bhindi; General knowledge of post-harvest diseases of fruits and vegetables and their control.

Diseases of Oil Seed Crops viz. *Linum*, *Seasamum*, Groundnut, Mustard and Sunflower

Diseases of Fruit Trees- With special reference to important diseases of the following Citrus, Apple, Mango, Banana and Grapes.

Module IV	Bacterial Diseases	15 hrs

Bacterial diseases of plants - Bacterial blight of rice, Tundu disease of wheat, Angular leaf spot of cotton, stalk rot of maize, Fire blight of Apple, Bacterial soft rot of fruits and Vegetables.

Viral Diseases of Plants- Bunchy top of Banana, Leaf curl of Papaya, Yellow vein mosaic of Bhindi. Mosaic of Cucurbits, Viral diseases of Tobacco, Potato and Tomato.;

Mycoplasma/Phytoplama (PPLO) Diseases of Plants- Citrus greening, Rice yellow dwarf, Little leaf of Brinjal, Sandal Spike; Nematode Diseases of Plants: General knowledge of plant parasitic nematodes and important nematode diseases viz. Root knot of Vegetables, Ear cockle of wheat.

Suggested Readings

1. Aneja, K.R. (2015). Experiments in Microbiology Plant Pathology and Biotechnology. New Age International Publisher, New Delhi. 6th Edition.
2. Dubey and Maheshwari. (2016). Practical Microbiology. S. Chand and Company Private Limited, New Delhi.
3. Hait, G. (2016). A Textbook of Mycology. New Central Book Agency, Kolkata.
4. Nair, L.N. (2001). Topics in Mycology and Pathology. New Central Book Agency, Kolkata.
5. Sethi and Walia. (2011). A Textbook of Fungi & Their Allies. Macmillan publishers, New Delhi. India.
6. Singh, H. (1983). Mushroom Growing In India. Steriling Publisher Private Limited, Bangalore.
7. Singh, H. (1983). Mushroom Growing In India. Steriling Publisher Private Limited, Bangalore.

Suggested URLs/Websites:

- https://apsjournals.apsnet.org/doi/10.1094/PHYTO-08-19-0300-IA

Master of Science (Botany)	**Semester IV**
Course Code	**PG-BOT (06)-S4-T4-SF1**
Course Name	**Plant Resources**
Course credit	**04**
Course working hours	**60 hours**
Course structure	**Theory and Practical**

Course objectives: This course aims to enhance increased understanding of students associated with knowledge of plants with immense economic values.

Course Learning Outcomes:

CO1: Students will be able to understand morphology and anatomy of plants of different economically valuable traits

CO2: Students will understand basic knowledge of pharmacognosy and drug evaluation.

CO3: Students will know the properties of plant secondary metabolites.

CO4: Students will understand types of commercially exploited plants by people.

Course Content:

Module I	Economic Botany	15 hrs

Food plants: History, origin, distribution, and nature
Morphology and anatomy of: Fiber yielding plants, forest resources (timber and non-timber plants), gum and resin yielding plants, fumitories and masticatories, spices, and condiments; Food adulteration

Module II	Pharmacognosy	15 hrs

Introduction, classification of crude drugs, plant anatomy (stomata, trichomes, xylem, phloem, ergastic substances); Evaluation of drugs: organoleptic, microscopic, chemical, physical and biological; Drug adulteration

Module III	Phytochemistry	15 hrs

Structure, classification, properties, importance and plant sources of: alkaloids, terpenoids, phenolics, steroids, glycosides

Module IV	Industrial Botany	15 hrs

Paper and pulp industry: Paper making, raw materials, manufacture of wood pulp, paper manufacture, kinds of paper and paper products.

Beverages: Source, plant description, cultivation, manufacturing, chemical composition- Tea Coffee and Cocoa.
Dyes: Plant sources (Description, chemical nature, extraction of dyes).
Essential oil: Occurrence, extraction, essential oils used in perfumery and other industries.
Rubber and latex: Classification of rubber, Natural rubber- source, cultivation, collection oflatex, processing, uses of rubber.

Suggested Readings

1. Ali Mohammed (1998) Textbook of Pharmacognosy. CBS Publi., New Delhi.
2. Kokate, C.K., Purohit, A.P. & Gokhale, S.B. (2019).6th Edt. Pharmacognosy. Nirali Publication, Pune.
3. Sabnis, S. D. and Daniel, M. (1990) A Phytochemical approach to Economic Botany. Kalyani Publi., New Delhi.
4. Sharma, O. P. (1996) Hill"s Economic Botany. TMH Publi., New Delhi.

Suggested URLs/Websites:

- https://www.uou.ac.in/sites/default/files/slm/BSCBO-302.pdf
- https://content.kopykitab.com/ebooks/2014/06/3256/sample/sample_3256.pdf
- https://botany.org/home/resources/plant-talking-points/what-is-economic-botany.html

Master of Science (Botany)	**Semester IV**
Course Code	**PG-BOT (06)-S4- T4-Foundation Course II**
Course Name	**Applied Botany**
Course credit	**04**
Course working hours	**60 hours**
Course structure	**Theory and Practical**

Course objectives: This course aims to enhanced increased understanding of knowledge of plants withimmense economic values for M.Sc. students opting non-subject centric foundation course.

Course Learning Outcomes:

CO1: Students will be able to know the concept and types of entrepreneurships and start-ups.

CO2: Students will elaborate commercial production of plant products.

CO3: Students will understand different types of gardens, silvicultural practices and post harvesting techniques.

CO4: Students will understand types of ecoysystem, types of pollution and waste degradation methods

Course Content:

Module I	**Entrepreneurship in Botany**	**15 hrs**

Concept, definition, structure and theories of entrepreneurship; Types of start-ups; Types of entrepreneurship, Entrepreneurship of NTFP (collection/Production, value addition, marketing strategies), Biodiesel/bio-ethanol plant production, Trichoderma production for control of soil borne fungi, honey production., Plant enzyme production

Module II	**Green Herbal techniques**	**15 hrs**

Phytochemistry: Classification of secondary metabolites accumulated by the plants; extraction of phytochemicals

Plant based products: Techniques for extraction/preparation of various dyes, cosmetics, perfumes (essential oils), sweeteners (Stewia etc.), herbal medicine, nutraceuticals.

Fibre production: Coir, Jute, banana, cotton, silk cotton etc.

Cultivation of common medicinal herbs: Aloe vera, Curcuma longa, Zingiber officinale, Withania somnifera, Chlorophytum borivilianum

Module III	**Gardening, silviculture and Post harvesting techniques**	**15 hrs**

Gardening: History, types of gardens, landscape gardening, major gardens of the world. Floriculture: General introduction, nursery management, methods of propagation (Bonsai, cutting, grafting, budding) poly house and green house, commercial floriculture.

Silviculture: Introduction, Agro-forestry, avenue trees, ornamental shrubs and trees cultivation.

Kitchen gardening: Spinach, tomato, brinjal, coriander, drumstick, lady"s finger, chilly, curry leaf, methi and other spices etc.
Post harvest techniques: Vegetables, fruits, ornamentals, neutraceuticals

Module IV	Ecology and Biodegradation of Waste	15 hrs

Introduction, concept of ecosystem, types of ecosystems, food chain and food web. Pollution: Sources, consequences control of soil, air, and water pollution. Carbon credit. Various methods of biodegradation ofwaste materials.

Suggested Readings

1. Dash, M. C. (1993). Fundamentals of Ecology. WB Saunders can Co., Philadelphia.
2. Heywood, V. H. and Moore, D. M. (1984). Current concepts in Plant Taxonomy. Academic Press, London.
3. Jones, S. B., Jr. and Luchsinger, A. E. (1986). Plant Systematics (gd edition). McGraw - Hill Book Co., New York.
4. Khalid, H. and Nawaz, K. (2014). Introductory plant taxonomy. Kalyani Publ., New Delhi.
5. Kochhar, P. L. (1986). Plant Ecology. Ratan Prakashan, Agra.
6. Kochhar, S. L. (1998). Economic Botany in tropics 2e. Macmillan India Ltd., New Delhi.
7. Kumar, H. D. (1994). Modern concepts of ecology. Vikas Publi. House Pvt. Ltd., New Delhi.
8. Sharma, O. P. (1996). Hill's Economic Botany. TMH Publ. Co. Ltd., New Delhi.
9. Woodland, D. W. (1991). Contemporary Plant Systematics, Pentice Hall, New Jersey.

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Template of Practical Examination

SEMESTER IV PRACTICAL VII

Time: 6 Hours		Full marks: 100
Q.1.	One experiment from Paper XIII A	15
Q.2.	One experiment from Paper XIII B	10
Q.3.	One experiment from Paper XIV C	15
Q.4.	One experiment from Paper XIV D	10
Q.5.	Spotting from Elective Paper II	10
Q.6	Spotting from paper-Plant Resources	05
Q.7.	Viva-voce	20
Q.8.	Practical Record	15

SEMESTER IV PRACTICAL VIII

MSc Research Project	Full marks: 100