Minutes of the
8th Meeting of the Board of Studies
of
Department of Botany
Central University of Jammu

Venue : Committee room, CUJ, Temporary Academic Block, Jammu

Date : Wednesday, 19th May, 2019

Time : 10:30 am

Department of Botany
Central University of Jammu

No.CUJ/BOT/2019/733 (A)

Date: 20th May, 2019

MINUTES OF THE 8th MEETING OF BOARD OF STUDIES (BOS) OF DEPARTMENT OF BOTANY

8.1 Minutes of the meeting of the 8th Board of Studies of Department of Botany held on 19th May, 2019 at 10.30 am in Committee Room, Temporary Academic Block, Central University of Jammu.

8.2 The following members attended the meeting:

1.	Prof. B. S. Bhau Head, Department of Botany Central University of Jammu	Chairman
2.	Prof. A. K. Wakhlu (retd.) Department of Botany University of Jammu, Jammu	External Expert Member
3.	Prof. Namrata Sharma Head, Department of Botany University of Jammu, Jammu	External Expert Member
4.	Prof. Veenu Kaul Department of Botany University of Jammu, Jammu	External Expert Member
5.	Dr. S. Vaishnavi Assistant Professor Department of Botany Central University of Jammu	Member Secretary

Dr. A. Bhat, Assistant Professor, Centre for Molecular Biology, CUJ, Member, could not attend the meeting as he was out of station.

8.3 Opening remarks by the Chair

The Chairman welcomed all the members, especially experts from outside the University, Prof. A. K. Wakhlu, Prof. Namrata Sharma and Prof. Veenu Koul, and thanked them for making it convenient to attend this meeting and providing invaluable inputs.

8.4 To consider and approve the proposed modifications in course structure and content for semester III of the Integrated M. Sc. Botany programme

The members were apprised that in its 6th meeting, the Board had approved replacement of the course on Phycology, then being offered in second semester of the Integrated M. Sc. Programme, by a more generic course on 'Plants in Human Welfare'. The course on Phycology was to be offered in third semester by merging with existing courses. This entailed modification in the course scheme to be offered in the ensuing semester III. The modified course scheme was placed before the Board. The members discussed the contents, and noted that these courses, particularly Mycology and Plant Pathology, and Phycology and Microbiology, were based on LOCF-based, UGC approved model courses.

The approved course scheme and contents for semester III are placed on record as Annexure-1.

8.5 To consider and approve the course structure for semesters VII - X of the Integrated M. Sc. Botany programme.

The course structure for semesters VII - X of the Integrated M. Sc. Botany programme was placed before the Board. The external experts suggested that it would be more fruitful to discuss it semester wise. Thus, the courses for semester VII were taken up for consideration and discussion (pt 8.6).

8.6 To consider and approve the course contents for semesters VII - X of the Integrated M. Sc. Botany programme.

The draft course contents for semesters VII - X of the Integrated M. Sc. Botany programme were placed before the Board. The contents pertaining to the seventh semester were discussed in great detail. The external experts lauded the efforts of the Head for incorporating latest contents in the syllabus, and provided invaluable inputs.

Due to paucity of time, semesters VIII – X could not be taken up. It was recommended that these be discussed in the next meeting of the Board.

The approved course contents for semester VII are placed on record as Annexure-2.

8.7 To consider and approve the subject experts for end semester examinations of Integrated M. Sc. Botany.

The panel of subject experts for end semester examinations of Integrated M. Sc. Botany were placed before the Board for approval.

The approved panel is placed on record as Annexure-3.

8.8. Any other item with the permission of Chair

8.8.1 In pursuance to Ordinance no.13, 5.VII, the Board authorized the Head to approve and forward the end-semester exam result of Ph.D. scholar, Mr. Aksar Ali Chaudhary to the School Board, and report the same in subsequent meeting for ratification.

8.8.2 Two elective courses on Ethnobotany and Molecular Markers and their Applications for Pre-Ph.D. course work were placed before the board.
The approved course contents for both courses are placed on record as Annexure-4.

8.9. The Meeting ended with a vote of thanks to the Chair.

Prof. B. S. Bhau

Prof. A. K. Wakhlu

Prof. Namrata Sharma

Prof. Veenu Kaul

Dr. S. Vaishnavi

Semester-III

Course Code	Paper Title	Credit	Contact hours / week		
			L	T	P
	Phycology and Microbiology	4	4	0	0
	Mycology and Phytopathology	4	4	0	0
	Bryology and Pteridology	4	4	0	0
	Lab based on Phycology and Microbiology	2	0	0	4
	Lab Based on Mycology and Phytopathology	2	0	0	4
	Lab Based on Bryology and Pteridology	2	0	0	4
	Interdisciplinary Elective	4	4	0	0
	Foundation Course	4	4	0	0
	Total	**26**	**20**	**0**	**12**

Semester III

Course title: Phycology and Microbiology

Course code: **4 credits [4-0-0]**

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

The course intends to acquaint students with the diversity in form, structure, nutrition and reproduction of algae, bacteria and viruses and their economic importance

Unit I: Bacteria

Historical perspective; General characteristics; Diversity in shape and size; Ultrastructure of cell; Archaebacteria, eubacteria; Reproduction – asexual (binary fission and endospore) and sexual including genetic recombination (conjugation, transformation and transduction); Nutritional types; Growth and metabolism.

Unit II: Viruses

General characteristics; Classification (Baltimore, 1971); Structure and replication of RNA virus (TMV), DNA virus (T4 and λ), lytic and lysogenic cycle.

General account of viroids, prions, mycoplasma and spiroplasma.

Unit III: Algae, Cyanophyta and Xanthophyta

Classification of algae (Fritsch, 1945); Range of thallus organization; Diversity in life cycles; Origin and evolution of sex in algae; Algal evolution and phylogenetic systematics of red, brown and green algae, Dinoflagellates, Diatoms, Cryptomonads and other unicellular algae.

Cell structure, morphology, reproduction, and life cycle of *Spirulina, Nostoc* and *Vaucheria.*

Unit IV: Chlorophyta and Phaeophyta and Rhodophyta

Cell structure, morphology, reproduction, and life cycle of *Volvox, Ulva, Oedogonium, Chara, Ectocarpus, Sargassum, Porphyra* and *Polysiphonia.*

Unit V: Economic importance of algae, bacteria and viruses

Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Commonly found algae in India; Economic importance of algae with reference to agriculture, food and fodder, water pollution, medicinal uses and sewage disposal; Algal cultivation

Suggested Readings

1. Campbell, N.A., Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky P.V. and Jackson, R.B. (2008). Biology, 8th edition. Pearson Benjamin Cummings, USA.
2. Fritsch F.E. (1956), The Structure and Reproduction of Algae, Cambridge University Press
3. Lee, R.E. (2008). Phycology, 4th edition, Cambridge University Press, Cambridge.
4. Pelczar, M.J. (2001). Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
5. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
6. Sharma T.A., Dubey, R.C. and Maheshwari, D.K. (1999). A Text Book of Microbiology. S Chand and Co, New Delhi.
7. Vashishta B.R., Sinha A.K. and Singh V. P. (2008). Botany for Degree Students. Algae. S Chand and Co, New Delhi.
8. Wiley, J.M, Sherwood, L.M. and Woolverton, C.J. (2013). Prescott's Microbiology. 9th Edition. McGraw Hill International.

Course title: Phycology and Microbiology Lab

Course code: **2 credits [0-0-4]**

Assessment	
Max. Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

Microbiology

1. Electron micrographs/Models of viruses – T4 and TMV, Line drawings/photographs of lytic and lysogenic cycle.
2. Types of bacteria from temporary/permanent slides/photographs. water bloom.
3. Electron micrographs or charts of bacteria, binary fission, endospore, conjugation.
4. Preparation of culture media - synthetic and non-synthetic.
5. Isolation of microorganisms.
6. Serial dilution technique.
7. Gram-staining.

Phycology

1. Microscopic observation of vegetative and reproductive structures of *Nostoc, Chlamydomonas, Volvox, Oedogonium, Chara, Vaucheria, Sargassum/Fucus, Ectocarpus,* and *Polysiphonia*, through temporary preparations and permanent slides.
2. Study of phototactic isolation of zoids of *Ulva* through chart.

Semester III

Course title: Mycology and Phytopathology

Course code:

4 credits [4-0-0]

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

The course intends to develop an understanding of fungi and lichens and appreciate their adaptive strategies. It further intends to help them identify common plant diseases caused by bacteria, viruses and fungi, and their control measures.

Unit I: Introduction to fungi, Chytridiomycota, Zygomycota and Ascomycota

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification with reference to Alexopoulos and Mims (1979).
Characteristic features, Ecology and significance, Thallus organisation, Reproduction, Life cycles of *Synchytrium* (Chytridiomycota), *Rhizopus* (Zygomycota) and *Saccharomyces, Aspergillus, Penicillium, Alternaria, Neurospora* and *Peziza* (Ascomycota); General account of heterokaryosis and parasexuality.

Unit II: Basidiomycota, allied fungi and Oomycota

Bsidiomycota: General characteristics and Classification of, Life cycles of *Puccinia, Ustilago* and *Agaricus*
Allied fungi: General characteristics and classification; Occurrence; Types of plasmodia and fruiting bodies.
Oomycota: General characteristics; classification, Ecology and life cycles of *Phytophthora* and *Albugo*.

Unit III: Symbiotic associations of fungi - lichens and mycorrhizae

Lichens – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Economic importance
Mycorrhizae - types and their significance.

Unit IV: Applied mycology

Ecology of fungi- soil fungi, sugar fungi, cellulose and lignin degrading fungi; Application of fungi in food industry (flavour and texture, fermentation, baking, organic acids, enzymes, mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (biofertilizers); Bioluminescence, Fairy Rings and Mushroom Cultivation; Mycotoxins; Biological control (mycofungicides, mycoherbicides, mycoinsecticides, myconematicides); Medical mycology

Unit V: Phytopathology

Concepts; General symptoms; Geographical distribution of diseases; Etiology; Host-pathogen relationships; Disease cycles; Prevention and control measures of plant diseases caused by bacteria – citrus canker and angular leaf spot of cotton; Viruses – tobacco mosaic viruses, vein clearing; Fungi – early blight of potato, black stem rust of wheat, white rust of crucifers, loose and covered smut; Environmental relation and role of quarantine.

Suggested Readings

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition John Wiley & Sons (Asia) Singapore.
2. Sumbali G (2010) The Fungi 2nd edition Oxford, U.K. Alpha Science International.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi. 3rd edition. Cambridge University Press, Cambridge.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
6. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.

Course title: Mycology and Phytopathology Lab
Course code: ICBOT3C004L

2 credits [0-0-4]

Assessment	
Max. Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).

1. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of sexual stage from permanent slides/photographs.
3. *Peziza*: sectioning through ascocarp.
4. *Alternaria*: Specimens/photographs and temporary mounts.
5. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
6. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
7. Study of phaneroplasmodium from actual specimens and /or photograph.
8. Study of *Stemonitis* sporangia.
9. *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section/temporary mounts and sexual structures through permanent slides.

Lichens

10. Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides.
11. Mycorrhizae: ectomycorrhiza and endomycorrhiza (photographs).

Phytopathology

12. Herbarium specimens of bacterial diseases: Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

Semester III

Course title: BRYOLOGY AND PTERIDOLOGY

Course code: **4 credits [4-0-0]**

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

Theory

Unit-1 General Account of Bryophytes

Introduction and classification of Bryophytes with special reference to Watsons scheme. Life cycle and alternation of generation -two theories. Origin and evolution of Bryophytes.

Unit-II Morphology, Anatomy and Reproduction

Riccia, *Marchantia*, *Anthoceros*, and *Funaria*. Ecological and economic importance with special reference to Sphagnum.

Unit-III General account of Pteridophytes with special reference to Psilophytales

Classification of pteridophytes (Reiners). Origin of pteridophytes (Any four theories). Structure and reproduction of *Rhynia*.

Unit-IV Morphology, Structure and Reproduction

Psilotum, Selaginella, Equisetum and *Pteris.*

Unit-V Evolution of seed habitat and importance of Pteridophytes

Stelar evolution, Heterospory and seed habit. Apogamy, Apospory. Ecology of pteridophytes. Economic importance of pteridophytes.

BRYOLOGY AND PTERIDOLOGY LAB.

Assessment	
Max. Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

Bryology: T.S thallus, whole mount rhizoids, dissection of sporophyte, whole mount spores and elaters (*Riccia, Marchantia, Anthoceros, Sphagnum, Funaria, Polytrichum*).

Pteridology: Photographs of vegetative and reproductive structures, T.S of stem, roots, V.S of leaf, whole mount spores, (*Rhynia*, *Psilotum*, *Lycopodium*, *Selaginella*, *Pteris* and *Marsilea*).

- The Department reserves the right to add or delete any practical in any semester during running the semester.

Reference:-

Bryology:

1.Bower, F.O. 1905. Origin of Land flora.

2.Bower, F.O. 1935. Primitive land plants.

3.Cavers, F.T. 1965. The interrelationship of Bryophytes.

4.Dutta, A.C. 1995. Botany for degree students Oxford university press.

5.Gilbert, M.Smith.1984. Cryptogamic Botany Vol.II TATA Mc Graw Hill publ.

6.Kashyap, S.R. The liverworts of western Himalayas and Punjab Plain, Vol.I & II.

7.Parihar, N.S. 1985. An Introduction to Embryophyta Vol. I Bryophyta.

8.Watson, E.V. 1974. The structure and life of Bryophytes - B.I. Publication

Pteridology:

1.Arnold, C.A. 1947. An Introduction to Palaeobotany.

2.Foster, A.S. and Gifford, E.M. 1959: Comparative Morphology of vascular plants.

3.Parihar, N.S. 1991. An Introduction to Embryophyta - Pteridophyta.

4.Rashid, A. 1979. In Introduction to pteridophyta.

5.Sporne, K.R. 1968. The Morphologyof Pteridophytes.

6.Walton,J.1940. Introduction to the study of fossil plants.

Department of Botany
Central University of Jammu
Draft course structure of M. Sc. Botany (2019-21)

SEMESTER 1/ 4 PAPERS (All Core)	Credits	Hours/week
Core – 4 credits		
Applied Phycology and Bryology	4	4-0-0
Applied Mycology and Microbiology	4	4-0-0
Concepts in Cell Biology	4	4-0-0
Systematics and Evolution	4	4-0-0
Applied Phycology and Bryology Lab	2	0-0-4
Applied Mycology and Microbiology Lab	2	0-0-4
Cell Biology Lab	2	0-0-4
Systematics and Evolution Lab	2	0-0-4
	24	16-0-16 = **32**

SEMESTER VII

Course title: Applied Phycology and Bryology

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

Course objectives

This course introduces the ecological and economic significance of algae. The underlying principles of algal growth and their response to light, temperature and nutrients are examined, and students carry out growth experiments with algae in test tubes and examine the theory all the way through to large scale outdoor raceways. The potential of algae to provide raw material for the biotech industry are reviewed, including up-scaling, growth in bioreactors, screening for compounds of industrial interest.

Theory

Unit 1: The Fundamental Physiological Processes of Algae

The Photosynthetic Pigments of Cyanobacteria and Algae: Chlorophylls; Carotenoids; Phycobiliproteins; Algae with Primary Plastids; Glaucophytes; Rhodophyta; Diatoms (Bacillariophyceae) and Related Phyla including the Phaeophyceae; The Need for Light Harvesting Antennae; Light-Harvesting Antennae in Cyanobacteria and Eukaryotic Algae; Control of Energy Supply to PSI and PSII: State Transitions, Absorption Cross-Section Changes and Spillover; State Transitions; Non-photochemical Quenching – Sensu Lato; The Xanthophyll Cycle; Spillover; pH Quenching; Orange Carotenoid Protein; Reactive Oxygen Species (ROS); Evolution of Photosynthetic Proteins Involved in Photoprotection and Light Harvesting; Physiology of Hydrogen Production from Cyanobacteria; Enzymes Related to Hydrogen Production in Cyanobacteria; Use of RNA Sequencing and Proteomics Analysis to Improve Hydrogen Production; Genome-Scale Metabolic Reconstruction

Unit 2: Physiology of Bryophytes

Membrane biophysics and related areas; Photosynthetic CO_2 fixation: Enzymes and transport mechanism; Photosynthetic pigments-Location and function; Pigment variables in relation to

ecophysiology; Genetic factors influencing photosynthetic pigments; Environmental factors influencing photosynthetic pigment composition-Light; Temperature; Desiccation; Nutrient availability; Pollution; Nutrient retention, desiccation and redistribution in mosses: Nutrient transfers in ecosystems; Nutrient capture; Uptake and Leakage during desiccation; Effect of ozone and atmospheric nitrogen deposition on bryophytes; Effects of increased carbon dioxide and nitrogen supply on mosses; Molecular genetic studies of *Physcomitrella patens*; Genes expression studies under stress conditions.

Unit 3: Genomics of Algae and Bryophytes

The Role of Algal Genomics in Opening Doors to New and Novel Approaches in Biotechnology; Adapting to Feast and Famine; Understanding Postendosymbiotic Innovation Through Phylogenomics and Experimentation; Genomics and Genetics of Diatoms; Microalgae, Functional Genomics and Biotechnology; Environmental and Evolutionary Genomics of Microbial Algae: Power and Challenges of Metagenomics; Molecular phylogeny of Bryophytes and peculiarities of their Chloroplast and Mitochondrial DNA; Bryophyte genomic and EST resources; Applied genomics in *Physcomitrella patens*;

Unit 4: Applied Phycology

Introduction to algal biotechnology: Resource potential of algae; commercial utility of algae. Algae as a source of food and feed; Algae as a source of pigments, fine chemicals, fuel and bio-fertilizers. Distribution of economically important algae in India; Algal immobilization and its applications; Blue-green algal bio-fertilizer: Method of preparation, application and its advantages over inorganic fertilizers. Liquid seaweed fertilizer: Method of preparation and application. Biodiesel from algae: algae producing biodiesel; Advantages over other sources of biodiesel; Cultivation and extraction methods. Phycoremediation. Role of algae in nanobiotechnology. Algal culture collection centers in India and abroad and their importance; Centers pursuing algal research in India and their field of interest. Uses of the following algae: *Spirulina, Dunaliella, Haematococcus, Chlorella, Scenedesmus, Botryococcus, Porphyridium, Hypnea. Gracilaria, Gelidium, Gelidiella, Kappaphycus, Grateloupia, Sargassum, Turbinaria, Cystoseira, Laminaria, Macrocystis, Porphyra, Caulerpa and Ulva.*

Unit 5: Applied Bryophytes

Bryophytes: Secondary metabolites from bryophytes; material for bedding, packing, plugging and stuffing; Horticultural uses; Moss garden; material for decoration; Medicinal uses; Food and erosion controllers; Seed bed for higher plants; Rock and mineral builders; bioindicators-ecological indicators; paleoecological indicators; mineral deposit indicators; water and air

pollution indicators; Biologically active substances from bryophytes: Fragrant and tastes; antimicrobial substances; Allergenic contact(dermatitis, Anti tumor and cytotoxic substances; Sources of stress-related genes; Production of complex Biopharmaceuticals with Moss Bioreactors; International Moss Stock Center

Practicals

Assessment	
Max. Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

Isolation and Culture of Algae

1. Quantitative Determinations of Algal Density and Growth
2. Preservation of Algal Samples
3. Periphyton Analysis
4. Sample Preparation Methods for Diatoms
5. Limnological studies of water bodies wrt. physical chemical and biological analysis
6. Extraction of DNA from algae & Bryophytes
7. Study of Cyanophyta; Chlorophyta & Charophyta; Phaeophyta; Rhodophyta
8. Algal indices
9. Study of external and internal stuructue of Marchantia,Anthoceros and Funaria.
10. Study of the external and internal structure of Psilotum and Lycopodium stem and structure of cone
11. Study of the external and internal structure of Equisetum stem and structure of cone
12. Study of the external and internal structure of Marsilea rhizome and petiole

SUGGESTED READINGS:

1. Shaw AJ and B Goffinet (2000) Bryophyte Biology. Cambridge University Press.
2. Geissler and Greene SW (1982) Bryophyte Taxonomy, methods, practices and floristic exploration. J Cramer, Germany.

3. Dyer AF (Ed) (1979) The experimental Biology of Ferns. Academic London.

4. Richardson DHS (1981) The Biology of mosses. John Wiley & Sons, Inc New York.

5. Bhatnagar SP and Moitra A (1996) Gymnosperms. New Age International (P) Limited, Publishers, New Delhi

6. Singh Hardev (1978) Embryology of Gymnosperms. Encyclopedia of Plant Anatomy. Vol X Gebruder Borntraegrl, Berlin, Stuttgart.

7. Vanderpoorten, A. & B. Goffinet. 2009. *Introduction to Bryophyte Biology*. 303 p. Cambridge University Press. Cambridge, UK

8. Goffinet, B. and A.J. Shaw (eds.). 2009. *Bryophyte Biology* (2nd edition). 565 p. Cambridge University Press.

9. Goffinet, B., V. Hollowell & R. Magill (eds.). 2004. *Molecular Systematic of Bryophytes*. Monographs in Systematic Botany from the Missouri Botanical Garden 98: 1-448

10. The Families and Genera of Vascular Plants, Vol 1- Pteridophytes and Gymnosperms (1990) Editors: Professor Dr. Karl Ulrich Kramer and P. S. Green

Semester – VII

Course title: Applied Microbiology and Mycology

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

Course Objectives

Fungi make an enormous contribution to human life. The aim of the current course is to provide a detailed description of the biology, biotechnological applications and medical significance of mycology.

Theory

Unit 1 Microbes and nutrient cycle

Historical developments in soil and microbiology, contributions of Beijerinck, Winogradsky, Fleming and Waksman. Importance of soil microorganisms – factors affecting the activities of soil microorganisms. Carbon and Nitrogen cycle in nature – molecular mechanism of Biological nitrogen fixation - symbiotic and non-symbiotic microorganisms – Microbial transformation of Phosphorus - Rhizosphere – R: S ratio – Microbial interrelationship in soil – Beneficial and harmful relationship.

Unit 2 Beneficial microbes

Microbes in the soil, types of microbes, fungi, protozoa, bacteria, phytoplasmas and spiroplasmas, viruses, invasive microbes, Beneficial microbes- Biofertilisers *Rhizobium*, *Azospirillum*, *Azotobacter*, *Gluconacetobacter*, *Azorhizobium*, phosphobacteria - Plant Growth Promoting Rhizobacteria (PGPR) - mycorrhizae - Blue Green Algae (BGA) and *Azolla* - Production and quality control of biofertilizers.

Unit III: Fungal cell biology genetics and physiology

Introduction, Morphology of yeasts and fungi, Ultra structure and function of fungal cell, The cell wall, cytoskeleton, Growth and cell division in budding yeast and fission yeast, Mycelium, multicellular organs, Fungal nutrition uptake, assimilation and cellular

biosynthesis, fugal metabolism, fungal growth and reproduction, sensing, responding and adaptation to change in external environment, adaptation for nutrient acquisition; Fungal life cycles, regulation of mating in fungi, unique characteristics of filamentous fungi that are advantageous got genetic analysis, genome sequencing in fungi, bioinformatics tools, comparative genomics, genomics and fungal tree of life cycle, online fungal genomic resources

Unit IV: Fungi as source of food, pharmaceutical and chemical commodities

Cultivated mushroom species, Mushrooms collected from nature, nutritional value of mushrooms, medicinal properties of mushrooms, fungal metabolism, antibiotic production, pharmacologically active compounds, chemical; commodities from fungi, Fungal enzymes in industry, Enzyme application, Future direction of industrial enzymes, applications of specific fungal enzymes

Unit V: Fungi Microbe interaction

Introduction, Fungal-fungal interaction, Antagonism, Mycoparasitism, Interaction chemistry and gene expression, Interaction between fungi and bacteria, Negative interaction, Positive and mutualistic effects, Viruses of fungi, Interaction between fungi and protists, Signaling-based interactions, Interactions via antibiosis, Interaction via modulation of the physiochemical environment, Interactions via chemotaxis and cellular contacts, Interactions via cooperative metabolism, Interactions via protein secretion and gene transfer

Practicals

Assessment	
Max. Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

1. Culture media preparation: PDA, CZA, Nutrient media, preparation of agar slants, method of inoculum transfer.
2. Different types of bacterial staining - Simple, Gram's, Capsular staining, Endospore staining Negative staining
3. Procedure for quantitative estimation of Microorganisms -Total count (haemocytometer) Viable count (Plate count)
4. Method for isolation and enumeration (CFU) of microorganisms in soil by serial dilution.

5. Microbial Examination by Petriplate expose method.
6. Pure culture technique of bacteria
7. Isolation of fungal pathogens from infected leaves
8. Study of the following diseases: i) Wart of potato ii) Downy mildew of grapes iii) Bunt of rice iv) Citrus canker
9. Isolation of seed borne fungi by 2-4 D method
10. Minimum inhibition concentration of salt on fungal growth
11. Quantitative estimation of cellulose by DNSA method

SUGGESTED READINGS:

1. Mehrotra, R.S, and Ashok Aggarwal, 2004. Plant pathology 12
2. Michael, J Pelczer, E.C.S. Chan, Noel R. Krieg, 1993.Microbiology concepts and applications, —McGraw Hill Inc, New York.
3. Moore Landecker, E.,1971. Fundamentals of Fungi. Prentice Hall Publication.
4. Mukta Bhargava, 2003. The latest portfolio of theory and practice in Fungi, A.S Saini Dominant publications.
5. Sambamurthy A.V. S.S. 2006. A Textbook of Plant Pathology. I.K. International Pvt. Ltd., New Delhi.
6. Ananthanarayanan, R. and CKJ. Paniker, 2004. Textbook of Microbiology. Orient Longman.
7. Dubey, R.C. and D.K. Maheswari, 2007. A Textbook of Microbiology, S. Chand & Company.
8. Powar, C.B and Daginawala 1991.General Microbiology Val-I and Vol-II Himalaya publishing.

Course Title: **CONCEPTS IN CELL BIOLOGY**

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

Course objectives: In this course, students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles Students will also apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Theory

Unit - I Plant cell, cell wall and biological membranes

Organization of a plant cell; Cell wall – biogenesis, temporal and spatial dynamism in structure, structural and functional roles, in planta and ex planta uses, cell wall biotechnology;

Biological membranes - from PLP model to Dynamically Structured Mosaic Model; Transport through membranes, concept of carriers, pumps, channels and receptors, membranes as sites and routes of intra- and inter-organism and environment interactions; Cells to tissues - cell polarity, cell fate determination, integration of plant cells in tissues.

Unit – II Cytoskeleton and Cytoplasmic components

Endomembranes - structure and functioning of endoplasmic reticulum and Golgi apparatus, protein sorting and vesicular traffic; Organellar architecture, structure and functions of vacuole and plasmodesmata; Cytoskeleton and cell motility - structure and role of microfilaments, intermediate filaments and microtubules; Cell organelles - structure, biogenesis and an overview of functions of mitochondria and chloroplasts; Microbodies-structure and functions of lysosomes, peroxisomes and melanosomes.

Unit - III Nucleus and its contents including structure and function of DNA.

Detailed structure of nuclear pore complex and nuclear lamina; Nuclear transport; Chromatin subunit structure - from DNA to metaphase chromosome, histone code, states of chromatin during replication and transcription, heterochromatization as a method of gene regulation

Unit - IV Cell Cycle

Cell turnover - cell division, cytokinesis and cell plate formation, cell cycle controls, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; apoptosis, breakdown of cell cycle control - cancer vs. plant tumors, programmed cell death, concept of hereditary and non-hereditary cancers.

Unit - V Methods in Plant Cell Biology

Introduction to methods in plant cell biology - optical and electron microscopy, techniques supplementing microscopy (cytochemistry, microprobe analysis, x-ray diffraction, etc.), Cell fractionation and visualization/characterization of various cell fractions, fluorescent probes, flow cytometry, transient expression, microinjection and micromanipulation, electrophysiological methods, plant histology, immunocytochemistry, in situ hybridization, organelle isolation

Suggested Reading

1. Alberts B, Johnson A, Lewis J, Raff Martin, Roberts K and Walter P. (2007) Molecular Biology of the Cell. Garland Publ., New York.
2. Bonifacino JS, Dasso M, Harford JB, Liipincott-Schwartz J and Yamada KM. (2004) Short Protocols in Cell Biology. John Wiley & Sons, New Jersey.
3. Bregman AA (1987) Laboratory Investigations in Cell Biology. John Wiley & Sons, New York.
4. Hawes C and Satiat-Jeunemaitre B (2001) Plant Cell Biology: Practical Approach. Oxford University Press, Oxford.
5. Hirt RP and Horner DS (2004) Organelles, Genomes and Eukaryote Phylogeny: An evolutionary synthesis in the age of genomics. CRC Press.
6. Karp G. (2008) Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
7. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008) Molecular Cell Biology. WH Freeman & Co., New York.
8. Ruzin SE (1999) Plant Microtechnique and Microscopy. Oxford Univ Press, Oxford.

9. Wischnitzer S. (1989) Introduction to Electron Microscopy. Pergamon Press, New York

CONCEPTS IN CELL BIOLOGY LAB

Assessment	
Max. Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

This laboratory course is based on theory course on Cell Biology. This laboratory course is designed to familiarize students with different aspects of cell biology involving a combination of microscopic, biochemical, genetic, and molecular techniques.

1. Demonstration of SEM using an appropriate plant material
2. Study of electron micrograph of a plant cell to observe and study cell organelles.
3. Staining nucleus with DAPI/Et Br and studying under fluorescence microscope
4. Staining mitochondria with Janus green B and studying under fluorescence
5. Differential centrifugation for isolation of cell fractions – Nuclear fraction
6. Differential centrifugation for isolation of chloroplasts to study:
   a. Hill reaction to measure intactness,
   b. measurement of size of chloroplasts using micrometry
   c. chlorophyll estimation
7. Differential centrifugation for isolation of mitochondria for estimation of succinic dehydrogenase activity
8. Spectrophotometric analysis of membrane stability in Beet root cells
9. Isolation of protein from plant samples and electrophoresis by SDS-PAGE
10. Study of cell cycle using BrDU activity
11. Study of induced cell senescence in leaf discs
12. Study of programmed cell death in plants

SEMESTER VII

Course title: Systematics and Evolution

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

Objective: This paper puts more emphasis on the use of new tools of biotechnology and molecular data in understanding phylogeny, and redefining affinities and arrangements of plant groups.

Theory

UNIT – I: APPROACHES TO PLANT SYSTEMATICS

Difference in Systematics and Taxonomy; Principles and procedures of plant systematics; Biosystematics: Steps in biosystematics, Biosystematic categories, Importance of Biosystematic studies. Phenetic versus phylogenetic systems.

UNIT-II: MOLECULAR SYSTEMATICS

Introduction to molecular systematics; Generating molecular data, types of molecular data, conserved genes for taxonomic analyses – Nuclear, Plastid and mitochondrial genes; molecular characters; homoplasy, phylogeny reconstruction, methods of estimating genetic diversity using molecular data and its modifications. Applications of molecular systematics in plant taxonomy. Cladistics (Phylogeny) – concepts, parsimony, cladograms and trees; characters: apomorphic and plesiomorphic characters, homologous vs analogous. Trees - monophly, polyphyly and paraphyly; rooted and unrooted. Phylogenomics as the modern trend in plant taxonomy.

UNIT-III: PHYLOGENY OF ANGIOSPERM

Diversity and classification of flowering plants; Biological diversity-concepts and applications; Diversity- patterns, indices and applications. APG IV system of classification of angiosperms; characteristics and phylogeny of clades: Orders – Amborellales, Nymphaeales, Austrobaileyales, Chloranthales; Clades (Magnoliids), (Monocots (Commelenids)), Order Ceratophyllales, (eudicots ((superrosids(Rosids (malvids, fabids))) (Superasterids (asterids (campanulids, lamids))))).

UNIT -IV. ORIGIN OF LIFE AND EVOLUTION

Origin of basic biological molecules – abiotic synthesis of monomers and polymers – Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell – evolution of prokaryote; Origin of eukaryotic cells, evolution of Unicellular eukaryotes, anaerobic and aerobic metabolism. Theories of organic evolution – Darwinism, Synthetic theory, Phyletic gradualism, Punctuated equilibrium; Molecular evolution – Concepts of neutral evolution, molecular divergence and molecular clocks – protein and nucleotide sequence analysis; gene duplication and divergence. Natural Selection, Reproductive isolation – types and species concept; Hardy –Weinberg equilibrium; applications. Evolution-mutation; random genetic drift.

UNIT V SPECIES CONCEPT, ISOLATING MECHANISM AND SPECIATION

Plant speciation: Allopatric, abrupt, sympatric, hybrid, apomictic speciation, Isolating mechanisms. Polyploidy, catastrophic selection, Biological species concept, Leaky isolation barriers, Gene flow and selection, species definition and classification, types of species: (1) Taxonomic species; (2) Biological species; (3) Semi species; (4) Micro species; (5) Successional species; (6) Biosystematic species; (7) Evolutionary species.

Practical's

Assessment	
Max. Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

LAB EXERCISES

1. Live plants/ Herbarium specimens of the following families will be provided in the class for description and identification (classification based on APG II, 2003): Basal Angiosperm and Magnoliids: Monocots: Commelinids: Basal Eudicots and Caryophyllids: Ranunculaceae, Rosids: Asterids.

2. Techniques in molecular systematics.

3. Phylogenetic analyses using PAUP.

4. Local flora study

5. Construction of phylogentic tree based on gene sequences available at NCBI database (each student may be given different gene sequences/taxa).

6. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparations of denodrograms.

7. Preparation and study of meiosis in 2 or more populations of a species as well as some classical cytological material.

8. Each student has to submit a herbarium of 10 sheets consisting of different population samples of a species and 10 species of a family or a group of families from any part of India.

SUGGESTED READINGS:

1. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
3. Hollingsworth PM, Bateman RM and Gornall RJ (1999). Molecular systematics and Plant Evolution. Taylor and Francis, London.
4. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002) Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
5. Nei M and Kumar S (2000) Molecular Evolution and Phylogenetics. Oxford University Press, New York.
6. Semple C and Steel MA (2003) Phylogenetics. Oxford University Press, Oxford.
7. Simpson MG (2006) Plant Systematics. Elsevier, Amsterdam.
8. Stuessy TF (2008) Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York.
9. Swafford DL (2001) PAUP*. Phylogenetic analysis using parsimony,version 4. Sinauer Associates, Sunderland.
10. Plant Systematics: A Phylogenetic Approach WS Judd, S Christopher, Campbell, AE Kellogg, PF Stevens (1999), Sinauer Associates Inc. Publishers.

Course title: Molecular Markers and their Applications

Course code:

4 credits [4-0-0]

Unit I: Genome organization:

Nuclear genome; Organellar genome; Unique sequences; Repetitive DNA, Classification of repetitive DNA - Tandem repeats, Interspersed repeats, Microsatellites, Minisatellites; Repetitive DNA as source of variation.

Unit II: Genetic Markers for Screening Variations

Traditional marker systems - Phenotypic markers, Biochemical markers; DNA-based markers - marker and DNA fingerprinting techniques: Concepts, classification and methodologies: Hybridization-based markers (Restriction Fragment Length Polymorphism, Oligonucleotide fingerprinting), PCR-based markers DAF, AP PCR, RAPD, SSRs, STMS, SCARs, ISSRs, MAAP, AFLP, SAMPL, CAPS, IRAP, REMAP, SSCP, DArTs, SNPs and SNP based assays for high-throughput genotyping, EST based markers, Sequencing by Hybridization (SBH), in situ hybridization

Unit III: Evaluation of Molecular Marker Data

Robustness and reproducibility; Fragment sizing and matching; Multilocus *vs* Single-locus approaches; Distance data; Discrete data; Discriminatory power of markers; Ordination, clustering and dendrograms; Population genetic analysis; Statistical testing

Unit IV: Applications of DNA Markers in Plant Sciences

History of DNA fingerprinting; Applications in genotype identification, genetic diversity evaluation, investigating taxonomic relationships; genetic mapping; Genetic *vs* physical maps; Phylogeography

Unit V: Applications of DNA Markers for Plant Breeding:

Marker assisted selection (MAS); Gene introgression and pyramiding; BSA Genotyping for physical mapping; Fingerprinting for BAC assembly; Types of mapping populations - F2 populations, RILs (recombinant inbred lines), Backcross lines, NILS (Near Isogenic Lines), HIF (Heterogenous Inbred Families), AILs (Advanced Intercross Lines); Genotyping tools for plant variety protection, hybrid purity tests, diagnostics and forensics.

Suggested reading:

Weising K, Nybom H, Wolff K and Kahl G (2005) DNA fingerprinting in Plants Principles, Methods and Applications, 2nd Edition, CRC Press, Taylor and Francis, USA

Karp, A., Ingram, D. S., Isaac, Peter G. (eds) (1998) Molecular Tools for Screening Biodiversity, Chapman and Hall, U.K.

Course Title: Ethnobotany

4 credits [4-0-0]

Course code:

Theory

Unit 1: Ethnobotany

Introduction, concept, scope and objectives, Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context, Major and minor ethnic groups or tribals of India, and their life styles. Ethnobotany and Folk medicines Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2: Plant Conservation

Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 3: Methodology in Ethnobotanical studies and legal aspects

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers.National gene bank, Benefit sharing.Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 4: Ethnopharmacology:

Definition, scope and applications in herbal medicines; Ethnopharmacology: Pharmacological evaluation of drugs from ethnomedicine (*Strychnosnux-vomica, Rauvolfiaserpentinaand Digitalis* species); Importance of ethnopharmacological studies. Criteria for pharmacological evaluation of drugs: Absorption, distribution, elimination, pharmacokinetics and drug reception; Pharmacological activity of plant drugs: Examples of plant drugs with effects on the autonomous and central nervous

systems, cardiovascular system and the gastrointestinal system; Plant drugs with antimicrobial activity; Plant chemicals in modern pharmacology: Biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, Vinca alkaloids; synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and biotransformation.

Unit 5: Ethnopharmacological validation of traditional medicine:

Bioassays related to active principles from plants: anti-bacterial, anti-fungal and anti-viral agents; anti-malarials; immuno-modulators; mediators of inflammation; anti-hepatotoxic agents; platelet aggregating factors; cardio-vascular agents; anti-inflammatory agents; diuretic agents; anti-allergic principles; fertility regulating agents; aphrodisiacs; hypo lipidaemic and hypo glycaemic agents; acute toxicity testing; Computerized database creation of ethnopharmacologically proven Indian medicinal plants

Suggested Readings

1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.

2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981

3) Lone et al,. Palaeoethnobotany

4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.

5) S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.

6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons-

Chichester

7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah._8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996)

8) Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd. 55.