

DRAFT COURSE STRUCTURE OF M. Sc. BOTANY (DEPARTMENT) SYLLABUS

TO BE IMPLEMENTED FROM July 2011 (semester I & II)

And July 2012 (semester III & IV)

Semester I		(26 cr.)
Course No.	Title of course	Credits allotted
BO 1.1	Plant Systematics I (Algae, fungi & Bryophytes)	4
BO 1.2	Biochemistry and Plant Physiology	4
BO 1.3	Genetics & Plant breeding	4
BO 1.4	Tools and Techniques in Botany	4
BO 1.5	Practicals based on BO 1.1 and 1.4	5
BO 1.6	Practicals based on BO 1.2 & BO 1.3	5
Semester II		(26 cr.)
BO 2.1	Plant Systematics II (Pteridophytes and Gymnosperms)	4
BO 2.2	Cell Biology	4
BO 2.3	Molecular Biology	4
BO 2.4	Plant Ecology	4
BO 2.5	Practicals based on BO 2.1 and 2.4	5
BO 2.6	Practicals based on BO 2.2 & 2.3	5
Semester III		(26 cr.)
BO 3.1	Plant Systematics III (Angiosperms)	4
BO 3.2	Developmental Botany	4
BO 3.3	Plant Genetic engineering	4
BO 3.4	Quantitative methods and Bioinformatics	4
BO 3.5	Practicals on BO 3.1 and BO3.2	5
BO 3.6	Practicals on BO 3.3 and BO3.4	5
Semester IV		(22 cr.)
BO 4.1	Optional paper I	4
BO 4.2	Optional paper II	4
BO 4.3	Practicals on optional paper II	4
BO4.4	Project on optional paper II	8
BO4.5	Review and Seminar on optional paper II	2
1. Optional paper I will consist of the following options: (any one)		
4.1a	Plant Pathology	4
4.1b	Plant diversity assessment and conservation	4
4.1c	Clonal propagation of plants	4
4.1d	Plant Organism interactions	4
2. Optional paper II will consist of the following options: (any one)		
4.2a	Advanced plant physiology	4
4.2b	Advanced angiosperm systematics and evolution	4
4.2c	Algology - Diversity and applications of algae	4
4.2d	Mycology - Diversity and applications of fungi	4
4.2e	Pharmacognosy - Medicinal plant biology	4
4.2f	Plant biotechnology	4
4.2g	Advanced Genetics and Plant breeding	4
4.2h	Advanced Environmental Botany	4

BO- 1.1 PLANT SYSTEMATICS I (NON VASCULAR PLANTS)-4C

Credit 1 (15 lectures):

1. Plant Systematics: Taxonomy Vs Systematics, Tools of Systematics, Principles and Methods of Taxonomy: Concept of species and hierarchical taxa, Biological nomenclature (International code of Botanical Nomenclature), Classical and quantitative methods of taxonomy of plants and fungi. (5L)
2. Algae and their position in “Domains and Kingdoms” System, Trends in classification of algae. (3L)
3. Chlorophyta – structure and evolution of thallus; unicellular eukaryotes (endosymbiotic theory), morphogenesis in *Acetabularia*; reproduction and life histories with reference to orders of green algae. (5L)
4. Charophyta and Euglenophyta: structure and reproduction. (2L)

Credit 2 (15 lectures):

1. Phaeophyta: general account of morphology, anatomy, reproduction and life histories. (3L)
2. Rhodophyta: classification, thallus structure, reproduction, reproductive strategies and life histories. (3L)
3. Cyanophyta: ultrastructure; strategy of cell division; thallus organization, heterocyst. (2L)
4. Brief introduction of Chrysophyta, Xanthophyta, Bacillariophyta, Dinophyta. (2L)
5. Chromista – Its present status in classification; general characters, classification up to orders; Lichen: types, morphology and reproduction. (4L)
6. Fossil fungi: Occurrence and their significance. (1L)

Credit 3 (15 lectures):

1. An outline of latest classification system proposed by Ainsworth or Alexopoulos (2L)
2. Myxomycotina: structure, life cycle patterns of major classes (1L)
3. Mastigomycotina: structure, life cycle patterns of major classes. (2L)
4. Zygomycotina: structure, thallus organization, evolution of sexual reproductive structures. (2L)
5. Ascomycotina: thallus organization, centrum development, different types of ascocarps (3L)
6. Basidiomycotina: tissue differentiation, fruit body organization (3L)
7. Deuteromycotina: types of conidial ontogeny and fruit body organization (2L)

Credit 4 (15 lectures):

1. Systems of classification of Bryophytes. (1L)
2. Distribution, morphological, anatomical, reproductive studies and comparative account of sporophytes and gametophytes and interrelationships along with their fossil relatives of the following orders:
 - (a) Sphaerocarpales, Calobryales, Takkakiales (2L)
 - (b) Marchantiales (2L)
 - (c) Jungermanniales (3L)
 - (d) Anthocerotales (1L)
 - (e) Sphagnales (1L)
 - (f) Andraeales (1L)
 - (g) Polytrichales, Buxbaumiales (2L)
 - (h) Eubryales, Funariales (2L)

References- Algae:

1. Brodie, J. and Lewis, J. (2007). (Ed.) Unravelling the algae: the past, present and future of algal systematics. CRC press, New York, pp. 335.
2. Bellinger, E. G. and Sigeo, D. C. (2010). Freshwater algae: Identification and use as bioindicators. Wiley-Blackwell, UK, pp. 271.
3. Cole, K. M. and Sheath, R. G. (1990). *Biology of the red algae*. Cambridge University Press. USA, Pp. 503.
4. Desikachary, T.V. (1959). *Cyanophyta*. ICAR, New Delhi.
5. Graham, L. E. and Wilcox, L. W. (2000). *Algae*. Prentice-Hall, Inc. pp. 640.
6. Krishnamurthy, V. (2000). *Algae of India & neighbouring countries I. Chlorophycota*, Oxford & IBH, New Delhi.
7. Lee, R. E. (2008). *Phycology*. Cambridge University Press, pp. 547.
8. Misra, J. N. (1966). *Phaeophyceae in India*. ICAR, New Delhi.
9. Prescott, G. W. (1969). *The algae: A review*. Nelson, London.
10. Smith, G. M. (1950). *The fresh water Algae of the United States*, Mc-graw Hill, Newyork.
11. Srinivasan, K. S. (1969) *Phycologia India*. Vol I & Vol II B.S.I. Calcutta.

References – Fungi:

1. Alexopolus, C. J., Minms, C. W. and Blackwell, M. (1999). (4th edn) *Introductory Mycology*. Wiley, New York. Alford, R. A..
2. Deacon, J. W. (2006). *Fungal biology*. (4th Ed.) Blackwell publishing, ISBN. 1405130660.
3. Kendrick, B. (1994). *The fifth kingdom* (paperback), North America, New York, Publisher: 3rd edition, ISBN- 10: 1585100226.
4. Kirk et al., (2001). *Dictionary of the fungi*, 9th edition, published Wallingford : CABI, ISBN: 085199377X.
5. Mehrotra, R. S. and Aneja, K.R. (1990). *An introduction to mycology*. New age publishers, ISBN 8122400892.
6. Miguel U., Richard, H. and Samuel, A.(2000). *Illustrated dictionary of the Mycology*, Elvira Aguirre Acosta, Publisher: St. Paul, Minn: APS press, ISBN 0890542570.
7. Webster, J. and Rpland W. (2007). *Introduction to fungi*. (3rd Ed.), Cambridge University Press, 978-0-521-80739-5.

Reference- Bryophyte:

1. Cavers, F. (1976). *The inter relationships of the bryophyte*. S.R. Technic, Ashok Rajpath, Patna.
2. Chopra, R. N. and Kumar, P. K. (1988). *Biology of bryophytes*. John Wiley&Sons, New York, NY.
3. Kashyap, S. R. (1932). *Liverworts of the Western Himalayas and the Panjab plain* (illustrated): Part 2 The Chronica Boanica New Delhi.
4. Kashyap, S. R. (1929). *Liverworts Of The Western Himalayas And The Panjab Plain Part 1* Chronica Botanica New Delhi.
5. Parihar, N. S. (1980). *Bryophytes: An introduction to Embryophyta Vol I*, Bryophya central Book Depot.
6. Prem puri (1981). *Bryophytes: Morphology, Growth and Differentiation*, Atma ram and Sons, New delhi.
7. Udar, R. (1975). *Bryology in India: Chronica Botanica Co.*, [c], New Delhi.
8. Udar, R. (1970). *Introduction to bryophyta* Shashidhar Malaviya Prakashan Lucknow
9. Watson, E. V. (1971). *Structure and life of bryophytes 3rd*, Hutchinson University Library London.

BO 1.2 Biochemistry and Physiology

Credit 1 - Basics of biochemistry

Structure and properties of water, its biological significance. Ionization of water, pH, acids and bases, dissociation constants, buffers	3L
Protein structure- Amino acids-structure and properties. Weak molecular interactions and secondary, Tertiary and quaternary structure of proteins, domains	5L
Enzymology- Classification and properties of enzymes, units of enzyme activity. Enzyme kinetics – substrate concentration and rate ; Km. Competitive and noncompetitive inhibitors. Covalent and allosteric regulation. Coenzymes, Isoenzymes and co-factors	7L

Credit 2 – Biosynthetic pathways

Building blocks of biological macromolecules – amino acids, sugars, fatty acids, purine and pyrimidine bases. Their biosynthesis and metabolism.	5L
Structure, biosynthesis and metabolism of polysaccharides and lipids. Their role in plants	5L
Secondary metabolites – Biosynthetic pathways of major classes of secondary metabolites. Examples of each class and their role	5L

Credit 3 – Nutrition, Transport and Bioenergetics

Water uptake, transport and transpiration. Stomatal physiology	3L
Uptake and assimilation of nitrogen, phosphorous and sulphur from soil. Nitrogen fixation. NUE, WUE Source and sink relationship	5L
Ion and solute transport	4L
Bioenergetics – free energy, changes in free energy during chemical reactions, entropy and enthalpy, high energy compounds, synthesis of ATP, activation energy	3L

Credit 4 – Metabolism

Photosynthesis – Measurement of rate of photosynthesis. Light and dark reactions Photoinhibition, Regulation of photosynthesis, Photorespiration	7L
Respiration – Measurement of respiration rate Regulation of glycolysis, citric acid cycle, pentose phosphate pathway. Terminal oxidation and the cyanide resistant pathway. Terminal oxidation and the cyanide resistant pathway. Gluconeogenesis	3L
Plant growth regulators – types, structure, Biosynthesis and metabolism Physiological effects Growth inhibitors and retardants, brassinosteroids, applications Changes in plant metabolism under stress.	5L

References

- Biochemistry and molecular Biology of Plants – B. B. Buchanan, W. Gruissem and R. L. Jones. American Society of plant physiology, Maryland, 2000.
- Principles of biochemistry –A. h. Lehninger
- Biochemistry – L. Stryer, Freeman and co., New York, 2002
- Biochemistry and Molecular biology –W. H. Elliot and D. C. Elliot, Oxford University press, New York, 1997
- Plant Biochemistry – H. W. Heldt, Academic Press, California, 2004
- Introduction to Biochemistry – T. W. Goodwin and E. I. Mercer, CBS Publishers, New Delhi, 1998
- Plant hormones – Ed. P. J. Davis, Kluwer Academic Publishers, Dordrecht, Netherlands 2004

BO 1.3 Genetics and Plant Breeding

Credit- 1

1. Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Concept of Gene: Allele, multiple allele, pseudoallele. Codominance, Incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance, expressivity and phenocopy. **3L**

2. Mutant screen and complementation test, Chromosomes and heredity - Chromosomal determination of sex, sex linkage, sex limited and sex influenced characters. Pedigree analysis, Genetic disorders in humans. **4L**

3. Inheritance of mitochondria and chloroplast genes, maternal inheritance and its effect. **3L**

4. Inheritance of complex traits - introduction to complex traits, Polygenic inheritance. Heritability and its meaning. **5L**

Credit- 2

1. Microbial genetics: mutant phenotypes, Methods of genetic transfers- transformation, conjugation and transduction in bacteria and genetic recombination, mapping of bacterial genome by interrupted mating. **3L**

2. Phage genetics: Phage mutants, Lytic and lysogenic cycles in phages. genetic recombination, specialized transduction, site specific recombination, mapping the bacteriophage genome, Fine structure analysis of rII gene in T4 bacteriophage. **4L**

3. Linkage and mapping in eukaryotes: Linkage and crossing over, Recombination: homologous and non-homologous, genetic markers, Linkage maps, lod score for linkage testing, mapping by 3 point test cross, mapping by tetrad analysis in Yeast and *Neurospora*. **8L**

Credit- 3

1. Cytogenetics: Karyotype, dosage compensation. Numerical alterations and Structural alterations of chromosomes. Euploidy and aneuploidy, Deletion, duplication, inversion, translocation, complex translocation heterozygotes, Robertsonian translocations, BA translocations. **4L**

2. Population genetics: Gene pool, allele frequencies and genotype frequencies, random mating and Hardy-Weinberg principle and its implications, test for random mating, differences among population, rate of change in gene frequency through natural selection, mutation, migration and random genetic drift. Isolating mechanisms, speciation; allopatricity and sympatricity. **4L**

3. Quantitative genetics: Inheritance of characters based on quantitative data, estimation of genes, their probability. **2L**

Nature of gene action and components of genetic variance. Concept of combining ability, covariance, resemblance between relatives and heritability. Factors influencing genetic variance, Detection on nature and magnitude of genetic variance. **3L**

GXE interaction- detection, quantification and problems. Environmental and genotypic variance partitioning. Stability, adaptability and adaptation. **2L**

Credit- 4

- 1. Plant Breeding:** Pre & Post Mendelian developments, objectives, plant breeding in India. Patterns of evolution in cultivated crop species **1L**
- 2. Plant Genetic resources:** Centers of origin, distribution and areas of diversity. Importance of genetic diversity in crop improvement and its erosion, conservation and regulation. **2L**
- 3. Reproductive systems, population structure and breeding strategies**
Sexual reproduction, (cross and self pollination) asexual reproduction, pollination control mechanisms and implications of reproductive systems on population structures. Genetic structure of populations. **2L**
- 4. Selection methods in self, cross pollinated and asexually propagated crops.** **5L**
- 5. Hybridization and its role, Inter-varietal and wide crosses. Principles of combination breeding and its application.** **3L**
- 6. Role of induced mutation and polyploidy in Breeding.** **2L**

Reference:

1. **Atherly, A.G., Girton, J.R. and Mcdonald, J. F.** (1999) The science of genetics. Sauders College Pub. Fort Worth USA.
2. **Burnham, C.R.** (1962) Discussions in cytogenetics. Burgess Pub. Co., Minnesota.
3. **Hartl, D.L., Jones E.W.**(2001). Genetics: Principle and analysis (4th edn) Jones and Barlett Pub., USA.
4. **Khush, G S** (1973) Cytogenetics of Aneuploids. Academic press New York, London.
5. **Lewin, B.** Genes VIII. Oxford, University press. New York, USA.
6. **Russel, P.J.** 1998. Genetics (5th edn). The Benjamin/ Cummins Pub. Co., Inc. USA.
7. Snustad, D.P. and Simmons, M.J. 2000. Principles of genetics (4th edn). John Wiley and Sons, Inc., USA.
8. **David Freifelder,** Microbial Genetics
9. **Strickberger, M.W:** Genetics (4th edn). Mcmillan Publishing company, New York.
10. **Griffiths, A.J.F and Gilbert, W.M** (2nd edn). Modern genetic analysis. W.H. Freeman and Company, New york.
11. **Singh, B.D.**(2005). Plant breeding: principles and methods. 7th edn.
12. **Allard, R.W.**(1960), principles of plant breeding. John Wiley and sons, Inc., New York.
13. **Chopra, V.L.** (2000) Plant breeding: Theory and practice 2nd edn. Oxford & IBH Pub., Co., ltd. New Delhi.
14. **Jain, H.K. and Kharwal, M.C.**(2003) Plant breeding: Mendelian to molecular Approaches. Navrosa Publishing House Pvt. Ltd., New Delhi.

15. **Mandal, A.K. Ganguli, P.K., Banergee, S.P.** 1991. Advances in Plant breeding. Vol 1 and 2, CBS Pub. & distributors.
16. **Sharma, J.R. 1994.** Principles and practices of plant breeding. Tata McGraw Hill. Pub. Co. Ltd. New Delhi.
17. **Simmonds, N.W.** 1979 Principles of crop improvement. Longman, London and New York.

BO 1.4 Tools and Techniques in Botany

Credit 1:

Microscopy and microscopic techniques: Light, phase contrast, fluorescence, electron, confocal microscopy. Flow cytometry. (7L)

Dissection, maceration, squash, peeling and whole mount- pretreatment and procedures.

Microtomy -Serial sectioning, double / multiple staining (4L)

Histochemical and Cytochemical techniques – localization of specific compounds / reactions / activities in tissues and cells (4L)

Credit 2:

Spectroscopic techniques: Visible, UV, IR spectrophotometry, fluorimetry, NMR and ESR spectroscopy, circular dichroism, atomic absorption and mass spectrometry. (10L)

Radioactive techniques: Isotopes and their half life, detection and measurement of radioactivity radiation counters, liquid scintillation counters, autoradiography. Dosimetry. (5L)

Credit3:

Chromatographic techniques: Paper, thin layer and column chromatography, gel filtration, ion exchange and affinity chromatography, high pressure liquid chromatography, gas chromatography. (8L)

Electrophoretic techniques: Supports, electrophoresis under native, dissociating and denaturing conditions, isoelectric focusing, staining, activity staining. 2-D electrophoresis, MALDI-TOF (7L)

Credit 4:

Immunological techniques: Immune response. Antibodies and their specificity, antigen-antibody interactions, immunodiffusion and immunoelectrophoresis techniques, immunoassays, western blotting (8L)

Electrochemical techniques: Electrical conductivity, pH meter, oxygen electrode. (3L)

Centrifugation techniques: High speed centrifuges, rotors, ultracentrifugation, density gradient centrifugation (4L)

References:

1. P. Gunasekaran 1995, "Laboratory Manual in Microbiology". New Age International (P) Ltd.
2. M. L. Srivastava, 2008, "Bioanalytical Techniques". Narosa Publishing House (P) Ltd.
3. O. L. Gamborg, G. C. Philips (Eds.), 1995 "Plant Cell, Tissue and Organ Culture Fundamental Methods". Narosa Publishing House (P) Ltd.
4. K. V. Krishnamurthy 1999, "Methods in Cell Wall Cytochemistry". CRC Press LLC
5. David T. Plummer 1987, " An Introduction to Practical Biochemistry". 3rd Eds. Tata McGraw-Hill Publishing Company Ltd.
6. S. Sadasivam, A. Manickam 1996, "Biochemical Methods" 2nd Eds. New Age International (P) Ltd.

7. S. M. Khasim 2002, "Botanical Microtechnique: Principles and Practice". Capital Publishing Company.
8. J. B. Harborne 1998, "Phytochemical Methods". Springer (I) Pvt. Ltd.
9. Keith Wilson, John Walker 2005, "Principles and Techniques of Biochemistry and Molecular Biology". Cambridge University Press.
10. Keith Wilson, John Walker 2000, "Practical Biochemistry Principles and Techniques". Cambridge University Press
11. Confocal Microscopy for Biologists - Alan R. Hibbs.
12. Confocal Microscopy: Methods and Protocols - Stephen W.
13. Confocal Laser Scanning Microscopy - Colin J. R. Sheppard and David M. Shotton.
14. Principles of Three-Dimensional Imaging in Confocal Microscopes - Min Gu
15. Physical principles of electron microscopy: an introduction to TEM, SEM, and AEM R. F. Egerton.
16. Light microscopy -Michael Eraut, Roger K. Snook
17. Light Microscopy: Methods and Protocols- Hélio Chiarini-Garcia
18. Plant histochemistry and cytochemistry: an introduction Peter B. Gahan
19. Methods in cell wall cytochemistry - K. V. Krishnamurthy
20. The plant cell wall - Jocelyn K. C. Rose

BO-1.5 PRACTICALS BASED ON BO 1.1

Practicals on Algae (2 C):	(Total: 6P)
1. Handling of compound microscope and methods to study algae	1P
2. Morphological observations, documentation (description and illustrations) and classification with reasons of taxa belonging to:	
a. Chlorophyta	3P
b. Charophyta	1P
c. Phaeophyta	1P
d. Rhodophyta	1P
e. Cyanophyta	1P
f. Minor groups	1P
3. Use of monographs	1P

Practicals on Fungi (2 C): **(Total 6P)**

Study of the representative genera belonging to Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina with respect to observations made based on tissue differentiation, accessory organs, asexual and sexual structures, and fruiting body: Ascocarp/Basidiocarp.

Subdivision Myxomycotina: Any five forms

Subdivision Mastigomycotina: Any five forms

Subdivision Zygomycotina: Any two forms

Subdivision Ascomycotina: Any ten forms

Subdivision Basidiomycotina: Any ten forms

Subdivision Deuteromycotina: Any four forms

Practical on Bryophytes (1C): **(Total: 4P)**

Morphological, anatomical, and reproductive studies of the following members:

- | | |
|--|-----------|
| 1. Marchantiales: <i>Astrella</i> , <i>Plagiochasma</i> , <i>Targionia</i> and <i>Cyathodium</i> . | 1P |
| 2. Metzerineae: <i>Fossombronia</i> , <i>Pallavicinia</i> , <i>Riccardia</i> and <i>Metzaria</i> | |
| 3. Jungermannie: <i>Porella</i> , <i>Fruillania</i> | 1P |
| 4. Anthocerotales: <i>Folioceros</i> , <i>Phaeoceros</i> , <i>Notothylus</i> | 1P |
| 5. Musci: <i>Sphagnum</i> , <i>Polytrichum</i> , <i>Pogonetum</i> , <i>Bryum</i> , <i>Fissidens</i> | 1P |

Practicals based on BO 1.4 Tools and Techniques **(Any 4 practicals)**

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|---|-------------|
| 1. Use of fluorochromes to visualise specific cell components | (1P) |
| 2. Micrometry | (1P) |
| 3. Maceration technique | |
| 2. Electrical conductivity and pH measurements | (1P) |
| 3. Absorption spectra of BSA / DNA and determination of absorption maxima | (1P) |
| 4. Gel filtration | (1P) |
| 5. Ouchterlony immunodiffusion technique for testing specificity of antigens and antibodies | (1P) |

BO 1.6 Practicals on BO1.2 and BO1.3

Biochemistry and Physiology

(Any 10)

1. Preparation of solutions of different concentrations. Conductivity and pH measurements **2P**
2. Enzyme assays – extraction and estimation of enzyme activity **2P**
3. Purification of enzyme by ammonium sulphate precipitation / gel filtration **2P**
4. Effect of pH and enzyme concentrations on enzyme activity **2P**
5. Effect of substrate concentration on rate of enzyme action and calculation of K_m . **1P**
6. Estimation of soluble proteins in germinating and non-germinating seeds by Lowry / Bradford's method **2P**
7. Estimation of total amino acids in germinating and non germinating seeds **1P**
8. Isolation and estimation of chlorophylls and carotenoids. Separation of pigments using column chromatography. Determination of absorption spectra of each pigment **2P**
9. Estimation of ascorbic acid in ripe and unripe fruits **1P**
10. Assaying IAA oxidase activity in green and senescent leaves **2P**
11. Studies on induction of amylase activity by GA₃ in germinating cereal grains **2P**

Genetics and Plant breeding

(Any 10)

1. Preparation of stains, Fixatives, preservatives and pretreatments to plant material **1P**
2. Karyotype analysis, preparation of somatic C- metaphase chromosomes of appropriate material using camera lucida drawing and Karyotype analysis in Allium/Aloe. **2P**
3. Study of meiotic configuration In maize/ Allium, Rhoe/Aloe, Tradescantia (prophase I, chiasma analysis). **3P**
4. Study of chromosomal aberrations in irradiated plant material **1P**
5. Study of Polygenic inheritance. **1P**
6. Problems of Mendelian inheritance and estimation of gene frequencies and heterozygotic frequencies, population genetics and Linkage. **1P**
7. Neurospora tetrad analysis. **1P**
8. Handling of Drosophilla for study of mono, dihybrid, and sex linked inheritance **1P**
9. Linear differentiation of chromosomes through banding techniques such as C-Banding, G-Banding and Q-Banding. **2P**
10. Penetrance and expressivity of PTC testing ability in humans and tongue rollers/non rollers **1P**
11. Floral Biology, study of Pollen Viability, germination in vitro and staining of any two major crops. **1P**
12. Study of monohybrid and dihybrid crosses and interactions. **1P**
13. Study of quality traits in rice, cotton/wheat/soybean/Brassica. **1P**
14. Use of Colchicine for induction of polyploidy in appropriate plant material. **2P**

BO 2.1 Plant Systematics - II (Pteridophytes and Gymnosperms)

Pteridophytes

CREDIT 1 (15L)

Recent Systems of classification of Pteridophytes (1L)

Telome concept (1L), Soral evolution in Filicales (2L), gametophytic evolution (1L)

Heterospory and seed habit (1L), Stellar Evolution(1L), Economic importance of Pteridophytes (1L)

Study of following fossil groups (7L)

Psilopsida salient features of Psilophytales External and internal morphology of *Rhynia*

Lycopsidea salient features of Lepidodendrales External and internal morphology of *Lepidodendron*, *Stigmaria*, *Lepidosrobus*, *Lepidophyllum*

Sphenopsida salient features of Calamitales, External and internal morphology of *Calamites*, *Annularia*, *Calamostactys*

Pteridosperms salient features of Pteridosperms *Lyginopteris* *Oldhamia*, *Lagenostoma*

CREDIT 2 (15 L)

Distribution, morphological, anatomical, reproductive studies and comparative account of sporophytes and gametophytes and interrelationships of the following orders:

Psilotales (1L), Lycopodiales (2L), Selaginellales (1L), Isoetales (1L), Equisetales (1L), Ophioglossales (1L), Marattiales (2L), Osmundales (1L), Filicales (3L), Marsileales (1L), Salviniiales (1L)

Gymnosperms

CREDIT 3 (15L)

Characteristic features, affinities and distinct features with Pteridophytes and Angiosperms

A brief survey of systems of classification, geographical distribution

Distribution of major groups in geological time (5L)

Affinities and distinct features of Progymnosperms, Pteridospermales, Cycadeoidales, Cycadales (3L), Caytoniales, Glossopteridales, Pentoxylales, Ginkgoales (3L)

Comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology and interrelationship of Cycadales, Ginkgoales (4L)

CREDIT 4 (15L)

Comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology and interrelationship of Cordiales, Voltziales, Coniferales (6L), Taxales, Gnetales (4L)

Seed development (2L)

In vitro experimental studies (1L)

Importance of Gymnosperms (2L)

References:

1. Agashe SN (1995) Paleobotany, Oxford and IBH Publ. Co. Pvt. Ltd, New Delhi.
2. Arnold AC (2005 Reprint) An Introduction to Paleobotany, Agrobios (India), Jodhpur.
3. Bhatnagar SP and Moitra A (1996) Gymnosperms. New Age International, New Delhi.
4. Biswas C and Johri BM (1997) Gymnosperms. Narso Pub., NewDelhi.
5. Chamberlain CJ (1986) Structure and evolution. CBS Publishers, New Delhi.
6. Eames EJ (1983) Morphology of vascular plants. Standard University Press.
7. Rashid A (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
8. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
9. Singh VP (2006) Gymnosperms (Naked seed plants): Structure and Development, Sarup and Sons, New Delhi.
10. Smith GM (1955) Cryptogamic Botany Vol II Mc Graw Hill.
11. Sporne KR (1986) The morphology of Pteridophytes. Hutchinson University Press. London.
12. Stewart WN and Rothwell GW (2005) Paleobotany and the Evolution of Plants, 2nd Edⁿ, Cambridge University Press.

13. Sundara Rajan S (1999) Introduction to Pteridophyta. New Age International Publishers, New Delhi.
14. Surange KR (1966) Indian fossil Pteridophytes. Council of Scientific and Industrial Research.
15. Parihar NS (1976) Biology and morphology of the Pteridophytes. Central Book Depot.

BO 2.2 Cell Biology

Credit 1 Cell organelles (I) –functional aspects

1. Cell wall – biogenesis, ultra structure and function. Growth - primary and Secondary wall **3L**
2. Cell membranes: molecular organization, Fluid mosaic model, membrane protein diffusion, electrical properties of membranes, transport across membranes - facilitated diffusion, carrier & channel proteins, transporters, active transport, transport of ions and solutes **4L**
3. Molecular organization of chloroplast and mitochondrial membranes. **3L**
4. Plasmodesmata – Structure and role in movement of molecules, virus transport **2L**
5. Vacuoles – Tonoplast membrane, biogenesis, transporters, role as storage organelle, transport across vacuolar membrane **3L**

Credit 2 Cell organelles (II) –functional aspects

1. Endoplasmic reticulum- Role in synthesis and transport of secretory proteins **2L**
2. Golgi complex – role in sorting , storage and secretion, **2L**
3. Lysosomes- membrane integrity and role **1L**
4. Glyoxysomes and Peroxisomes- structure, enzymes and functions **1L**
5. Cytoskeleton – composition and organization of microtubules, microfilaments. Tread milling and their role in cell division, signaling and intracellular traffic. Role in motility, flagella - Structure and organization. **4L**
6. Nucleus – Structure, organization and regulation of nuclear pore complex. Transport across nuclear membrane. **2L**
7. Ribosomes – Structure, assembly and dissociation of subunits, function. **2L**
8. Biogenesis of chloroplasts and mitochondria **1L**

Credit 3 Signal transduction

1. Signal transduction: Types of receptors ,G-proteins and G-protein coupled receptors **4L**
2. Phospholipid signaling, Ca⁺⁺-calmodulin cascade,diversity in protein kinases and phosphatases, secondary messengers, regulation of signaling pathways **5L**
3. Specific signaling mechanisms with suitable examples – biotic and abiotic stress, ABA induced stomatal closure, **4L**
4. Nuclear-organelle signaling during plastid development **2L**

Credit 4 Cell cycle, aging and cell death

1. Cell Cycle – Phases of Cell Cycle, functional importance of each phase, Molecular events during cell cycle, Check points, Cyclins and protein kinases, MPF (maturation promoting factor), Regulation of cell cycle. Methods to study cell cycle – labeled mitotic curve, flow cytometry, use of mutants. **8L**
2. Cell aging and cell senescence, programmed cell death- molecular aspects, regulation of cell death, PCD in response to stress **4L**
3. Apoptosis- Role of different genes, cell organelles during apoptosis, genetic control of apoptosis. **3L**

Reference Books:

1. Alberts B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. Molecular biology of the Cell (2nd edition). Garland Pub. Inc., New York.
2. Karp, G. 1999. Cells and Molecular Biology: Concepts & Experiments. John Wiley and Sons, Inc., USA.
3. Lodish S, Baltimore B , Berk, C and Lawrence K, 1995 , Molecular Cell Biology ,3rd edn, Scientific American Books, N.Y
4. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8th edn, Info-Med, Hongkong
5. Buchanan, Grissem and Jones, 2000, Biochemistry and Molecular Biology of Plants, American Soc. Plant Biologists, Waldorf
6. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA

BO2.3 Molecular Biology

Credit – 1 DNA

1. DNA structure – types of base pairing, unusual structures, topology **2L**
2. Melting and reassociation of DNA, Cot curves and kinetic complexity of DNA. Organization of genomes (from whole genome sequences), repetitive and unique sequences, C value paradox, gene duplication and divergence. Number of genes, exons. Rot curves and gene expression **3L**
3. Packaging of genomes in viruses, bacteria, organelles and nuclei. Structure of chromatin, nucleosome positioning. Histone modifications. Chromosome organization, centromeres, telomeres, specialized chromosomes **3L**
4. Initiation, elongation and termination of DNA replication, molecular machinery of DNA replication in prokaryotes and eukaryotes. **3L**
5. DNA damage and repair. **2L**
6. Molecular mechanism of recombination and transposition **2L**

Credit – 2 RNA

1. RNA structure – modified bases, pairing, secondary structure **2L**
2. Transcription units, RNA polymerases, initiation, elongation and termination of transcription in prokaryotes and eukaryotes, proof reading **5L**
3. RNA processing – Processing of tRNA, rRNA and mRNA. mRNA localisation **5L**
4. Non-coding RNAs, ribozymes and riboswitches **3L**

Credit – 3 Proteins

1. Protein synthesis – tRNA charging, ribosomal organisation Initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes. Proof reading **6L**
2. Post-transcriptional processing of proteins, Proteases and their role in processing and degradation of proteins **4L**
2. Targeting of organelle and secretory proteins. Localisation of membrane proteins. Chaperones and protein folding. **3L**
3. Seed-storage proteins and their genes in cereals and legumes. **2L**

Credit – 4 Regulation of gene expression

1. Regulation of transcription - Operons, repressors and inducers, positive and negative control, regulation of lytic and lysogenic cycles in phages. **4L**
2. Transcription factors in eukaryotes, response elements. Post-transcriptional regulation. **4L**
3. Regulation of gene expression at higher levels of genome organization, chromatin remodeling, locus control regions, enhancers and insulators **4L**
4. Regulation of protein synthesis, post-translational regulation, regulation of protein function **3L**

Reference books

1. Genes VIII- Benjamin Lewin, Oxford University Press Oxford, 1997
2. Genes IX– Benjamin Lewin, Jones and Bartlett, 2008
3. Genes X– Benjamin Lewin, Jones and Bartlett, 2011
4. Molecular Biology of the Cell – Alberts, B, Bray, D, Raff, M, Roberts, K and Watson JD, Garland Publishers, 1999
5. Principles of Biochemistry – Lehninger, W.H. Freeman and Company, 2005

BO 2.4 Plant Ecology

Credit 1: Plant relations with the environment

1. Plant relations with climatic factors such as water, precipitation, temperature, light and radiation. **5L**
2. Plant relations with edaphic factors: types of soil, soil moisture and water holding capacity of the soil, soil nutrients, soil microbes **5L**
3. Plant distribution with respect to topographic and climatic factors, centres of origin, migration **5L**

Credit 2: Population ecology

1. Ecological limits and the size of population, factors affecting population size, demes **3L**
2. Life history strategies, r and k selection, C-S-R triangle **3L**
3. Concept of metapopulation, extinction events, population viability analysis **3L**
4. Community structure and species diversity **3L**
5. Diversity types and levels (alpha beta, gamma), ecotone and edge effect **3L**

Credit 3 Ecosystems

1. Ecosystem - Components and organization **1L**
2. Energy flow and mineral cycling, carbon sequestration **2L**
3. Ecosystem types
terrestrial – forests, grasslands, deserts **4L**
aquatic – fresh water and marine **4L**
artificial - agricultural **1L**
4. Biomes: Classification and components **3L**

Credit 4 Plant ecosystem dynamics

1. Eco-physiology – Adaptive responses of plants to variation in:
Light – photoinhibition, protection against light-induced damage **3L**
Temperature – winter hardiness, vernalization, adaptation to high temperature **2L**
water availability – adaptations to drought and flooding **3L**
2. Plant succession – autogenic and allogenic, mechanism and phases **3L**
Serai communities and climax communities – hydrosere, lithosere, xerosere
halosere **4L**

References

1. Begon, M., Townsend, c. R., Harper, J. L. (2005). Ecology: From individuals to Ecosystems, 4th edition, Wiley-Blackwell.
2. Odum, E. P. (2007) Fundamentals of Ecology , 5th edition, Thomson books.
3. Coleman, D.C., Crossley, D. A., Handrix, P. F (2004) Fundamentals of Soil Ecology, 2nd edition, Elsevier academic press.
4. Ambhast, R. S. (1998) A Text Book Of Plant Ecology. (9th edition), Friend and co.
5. Canter L (1996) Environmental Impact Assessment, 2nd Edition, McGraw Hill Publishing Company.
6. Collier, B. D., Cox, G.W., and Miller, P. C. (1973). Dynamic ecology, Prentice-Hall, Inc. Englewood Cliffs, New Jersey.
7. De, A. K. (1994) environmental chemistry, Wiley Eastern publication.
8. Gurevitch, J., Scheiner, S. M., Fox, G. A. (2006) The ecology of plants, Sinauer Associates.
9. Hynes, H. B. N. (1978) Biology of polluted water, 1st edition, Liverpool University Press.
10. Kershaw, K. A. (1978) Quantitative and dynamic plant ecology, 2nd edition, Edward Arnold publication.
11. Kumar, H. D. (1981) Modern concepts of ecology, (8th edition), Vikas publication.
12. Barbour, M.G., Pits, W.D., and Burk, J. H. (1967) Terrestrial Plant Ecology, Addison-Wesley Publisher.
13. Crawley, M., Crawley, J., Crawley, M. (1997) Plant ecology, 2nd edition, Wiley-Blackwell.
14. Mishra, R. (1968) The Ecology Work Book, Oxford and IBH public. Co., Kolkata.
15. Mukherjee, B. (2000) environmental management: Basic and applied aspects of management of ecological environmental system, 1st edition, Vikas Publication House.
16. Mukherjee, B. (1996) Environmental Biology, 1st edition, Tata Mcgraw Hill.
17. Odum, E. P. (2007) Fundamentals of ecology, 5th edition, Thomson books.
18. Yadav, P. R., and Mishra, S. R. (2004) Environmental biology, Discovery publication, New Delhi.

BO 2.5 Practicals on BO2.1 and BO2.4

Pteridophytes and Gymnosperms (Any 10 practicals)

Pteridophytes

Morphological and/or anatomical and/or reproductive studies of the following members
With the help of live material and/ or herbarium specimens and/ or museum specimens and/ or permanent slides:

Psilotales: *Psilotum*, *Tmesipteris*, Lycopodiales: *Lycopodium* Selaginellales: *Selaginella*,
Isoetales: *Isoetes*, Equisetlaes: *Equisetum* (1P)

Ophioglosales: *Ophioglossum*, *Botrychium*, *Helminthostachys*, Marattiales: *Angiopteris*,
Osmundales: *Osmunda* (1P)

Filicales: *Anemia*, *Lygodium*, *Gleichenia*, *Ceratium*, *Goniopteris*, *Phymotodes*, *Pteris*,
Acrostichum, *Blechnum*, *Platyserum*, *Pteridium*, *Pleopeltis*, *Cheilanthis*, *Ceratopteris*, *Athyrium*,
Adiantum. (1P)

Salviniales: *Salvinia*, *Azolla*, Marsileales: *Marsilea* (1P)

Study of available fossil of Pteridophytes. (1P)

Gymnosperms

Cycadales

- External morphology of vegetative parts of *Cycas* sp., *Zamia*, *Encephalartos*
- Megasporangiate strobilli and megasporophylls of *Cycas* sp., *Ceratozamia*,
Zamia, *Encephalartos*
- Microsporangiate strobilli and microsporophylls of *Cycas* sp., *Ceratozamia*,
Zamia, *Encephalartos*
- Gametophytes and embryogeny: i) *Microcycas* - free nuclear stage, ii) *Zamia*
– archegonia and proembryo iii) *Cycas* – embryo
- Anatomy: T.S. of rachis and pinnae of *Cycas*, *Zamia* (2P)

Coniferales, Taxales and Ginkgoales

Preparation of double stained semi permanent slides (T.S., T.L.S and R.L.S) of wood of any two of the following genera

- Pinus*, *Cupressus*, *Araucaria*, *Agathis*, *Podocarpus*, *Taxodium*
- Study of male cones, microsporophylls and microspores – at least one genus from each family.
- Study of female cones, ovuliferous scales of *Pinus*, *Cupressus*, *Araucaria*,
Agathis, *Podocarpus*, *Taxodium*
- Gametophytes and embryogeny of *Pinus* – Archegonia, proembryo and suspensor (3P)

Ginkgoales
Study of morphological and/or anatomical and/or reproductive features (2P)

Gnetales
Study of habit, external morphology of *Gnetum*, and *Ephedra*
T.S., T.L.S and R.L.S of wood of *Gnetum*
Morphology of reproductive parts –
i) Male strobilus, microsporophylls, pollen grains of *Gnetum* and *Ephedra*
ii) Female strobilus of *Gnetum*
Study of available fossil Gymnosperms along with living specimens. (2P)

Plant Ecology (Any 10 Practicals)

1. Study of morphological and anatomical characteristics of plants under stress (2P)
2. Allelopathic analysis of the plants (2P)
3. To find the minimum size of sampling unit for studying plant communities (2P)
4. Determination of frequency, density, abundance, dominance, IVI and Richness of the species among plant communities (2P)
5. Studying succession at field level, hydroseric and xeroceric (2P)

Practicals BO2.6 on BO 2.2 BO2.3 (5C)

Cell Biology

(10 practicals)

1. Differential centrifugation for isolation of cell fractions – Nuclear fraction **1P**
2. Isolation of chloroplasts to study:
 - a. Hill reaction to measure intactness,
 - b. measurement of size of chloroplasts using micrometry
 - c. chlorophyll estimation **2P**
3. Isolation of mitochondria for
 - a. Estimation of succinic dehydrogenase activity
 - b. Microscopic observations using MitoTracker Green FM/
MitoTracker Red 580/ Janus green B **2P**
4. Isolation of lysosomal fraction and estimation of acid phosphatase activity **1P**
5. Study of electron micrographs of cell organelles **1P**
6. Study of cell cycle using BrdU (demonstration) **1P**
7. Isolation of protoplasts and viability staining to determine % viability. **1P**
8. Study of metaphase nucleus: Localization of euchromatin and heterochromatin. **1P**
9. Cytochemical studies of special cell types- guard cells, senescent cells, bundle sheath cells, meristematic cells, laticiferous cells, glandular cells, pollen grains **2P**
10. Study of induced cell senescence in leaf discs **1P**
11. Study of programmed cell death in plants **1P**
12. Ouchterlony immunodiffusion technique for testing specificity of antigens and antibodies. **1P**

Molecular Biology

(10 practicals)

(Any 10 practicals from the following)

1. Isolation of plasmid DNA and quantification **2P**
2. Electrophoretic separation of plasmid isoforms **1P**
3. Restriction digestion of plasmid DNA, electrophoresis and molecular weight determination of DNA fragments. **2P**
4. Isolation of plant genomic DNA and quantification **2P**
5. Effect of temperature and alkali on absorbance of DNA – hyperchromicity **1P**
6. Separation of seed-storage proteins from leguminous seed and quantitation of each fraction **2P**
7. SDS-PAGE separation of seed storage proteins from legumes. Determination of molecular sizes of the globulin subunits. **3P**