Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Curriculum under Credit Based Grading System

M.Sc. Botany

Semester-I & II

Run at college level from the

Academic Year 2015-2016

M. Sc. Botany
Course Structure

Sr. No.	Course No.	Title of the Course	Hrs	Credits Allotted	Theory				Practical	
					internal	External	(Maximum)	Minimum	Maximum	Minimum
Semester I										
01.	BOT 401	Cell Biology	08	4T + 2 P	20	80	100	40	50	20
02.	BOT 402	Molecular Biologogy	08	4T + 2 P	20	80	100	40	50	20
03.	BOT 403	Biology and diversity of Virus, Phytoplasma, Bacteria, algae and fungi	08	4T + 2 P	20	80	100	40	50	20
04.	BOT 404	Taxonomy of Angiosperms	08	4T + 2 P	20	80	100	40	50	20
05		Seminars and Tutorial	03	3T	--	--	--	--	--	--
		Total		**27 Credits**						
Semester II										
06.	BOT 405	Cytology and Genetics	08	4 T + 2 P	20	80	100	40	50	20
07.	BOT 406	Plant development and reproduction	08	4T + 2 P	20	80	100	40	50	20
08.	BOT 407	Biotechnology	08	4T + 2 P	20	80	100	40	50	20
09.	BOT 408	Plant Physiology and Metabolism	08	4T + 2 P	20	80	100	40	50	20
10		Seminars and Tutorial	03	3T	--	--	--	--	--	--
		Total		**27 Credits**						
Semester III										
11.	BOT 501	Biology and Diversity of Bryophytes, Pteridophytes and Gymnosperms	08	4T + 2 P	20	80	100	40	50	20
12.	BOT 502	Ecology and Conservation	08	4T + 2 P	20	80	100	40	50	20
1.	BOT 521 A BOT 521 B BOT 521 C BOT 521 D	Crop Genetics and Plant Breeding - I Plant Pathology-I Taxonomy of Angiosperms - I Advanced Plant Physiology and Biochem. - I	07	3T + 2 P	20	80	100	40	50	20
15.	BOT 522 A BOT 522 B BOT 522 C BOT 522 D	Crop Genetics and Plant Breeding - II Plant Pathology-II Taxonomy of Angiosperms - II Advanced Plant Physiology and Biochem. II	07	3T + 2 P Each	20	80	100	40	50	20
		Project Work	03	3T	--	--	--	--	--	--
16	Service Course	Plant Tissue Culture	04	4T	--	--	100	40	--	--
		Total		**29 Credits**						

Semester IV										
17.	BOT 504	Bioprospecting and Plant Resource Utilization	08	4T +2 P	20	80	100	40	50	20
18.	BOT 505	Genetic Engineering and Bioinformatics	08	4T + 2P	20	80	100	40	50	20
20.	BOT 523 A BOT 523 B BOT 523 C BOT 523 D	Advanced Genetics & Molecular Biology – I Plant Pathology – III Taxonomy of Angiosperms – III Plant Physiology – III	07	3T + 2P	20	80	100	40	50	20
21.	BOT 524 A BOT 524 B BOT 524 C BOT 524 D	Advanced Genetics & Molecular Biology – II Plant Pathology – IV Taxonomy of Angiosperms – IV Advanced Plant Physiology -IV	07	3T + 2 P Each	20	80	100	40	--	--
		Project Work	07	7T	--	--	--	--	50	20
		Total		**29 Credits**						

Total Credits requiredobtaining M. Sc. Degree in Botany

Semester I 27

Semester II 27

Semester III 29

Semester IV 29

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Total credits112

*** At least one service course**

BOT 401

Cell Biology

Unit I .i.**Prokaryotic and eukaryotic Cell:** The ultra-structural details and comparative assessment.

Unit II i. Plasma membrane: Molecular .organization, current models and functions. Cell wallarchitecture, biosynthesis, assembly, growth and cell expansion.

iiPlasmodesmata: Structure and role in movement of molecules andmacromolecules.

Unit III. i. Cytoskeleton: Organization and role of microtubules and microfilaments.Implications in flagellate and other movements.

ii. **Plant vacuole:**Tonoplast membrane, ATPases, transporters, as storageorganelle.

Unit IV. Chloroplast and Mitochondria: Ultrastructure, function and biogenesis. Theorganization of genome and patterns of gene expression.

Unit V. Nucleus: Microscopic and submicroscopic organization. Structure and function ofnuclear Envelope. The ultrastructure of nucleolus and its role in rRNA biosynthesis.

Unit VI. Ribosomes: Structure and site of protein synthesis. Mechanism of translation,details of initiation, elongation and termination. The structure and role of RNA.

Practicals based on Bot-401

1. To determine mitotic Index in different plant materials.
2. Karyomorpholpgical studies from slide/photograph.
3. Induction of mitotic abnormalities through chemical treatment.
4. Determination of chiasma Frequency in plants.
5. Fluorescence staining with FDA for cell viability and cell wall staining with calcoflour.
6. Demonstration of-SEM and TEM organelles.
7. Demonstration of acid phosphataes and succinic dehydrogenase activity in plants.
8. Localization of nuclear DNA by using Feulgen as a DNA specific stain.

BOT-402

Molecular Biology

Unit I. Cell signaling: Signal transduction, signaling pathways, second messengers, cAMP,genetic disorders ; due to the G protein defect. Lipid derived second messengers.Receptor tyrosine kinase and signaling pathway. Molecular biology of signaling.

Unit II. Other cellular organelles: Structure and functions of micro bodies,Golgi apparatus, Lysosomes and Endoplasmic reticulum.

Unit III. Proteinsorting: Targeting of proteins to organelles. Translocation of secretaryproteins across the ER membrane. The post translational modifications in RER.

Unit IV. Cell Cycle and its molecular aspects: Control mechanism, the role of cycline andcycline dependent kinases, Retinoblastoma and E_2F proteins. Cytokinesis and cell plateformation. Mechanism of programmed cell death (Apoptosis) and Senescens.

Unit V. Molecular Cytogenetics

i. Nuclear DNA Content: The C-value paradox, the COT value curve & its significance

ii. **Restriction mapping**: Concept and techniques, multigene families and their evolution.

iii. Computer assisted chromosome analysis, chromosome micro-dissection and micro cloning.

Unit VI. Laboratory Techniques: Microscopy, SEM & TEM,Ultracentrifugation, fractionation,Electrophoresis, PCR, GISH, FISH and Immunochemical techniques. The flow cytometry and confocal microscopy in karyotype analysis.

Practicals based on BOT-402

1. Demonstration of native and SDS PAGE profiles of seed proteins.
2. Isolation of plant DNA and its quantitation by spectrophotometric method.
3. Isolation of DNA and preparation of Cot curve.
4. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
5. Isolation of RNA and its quantitation by spectrophotometric method.
6. Separation of plant RNA by agarose gel electrophoresis and visualization by ethidium bromide staining,
7. Demonstration of Western blotting.
8. Estimation of seed proteins by Lowry's method.

Suggested Readings (For BOT-401 & 402 Theory)

1. Lewin, B. 2000, Genes VII, Oxford University Press, New York.

2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D.I 999.Molecular Biology of the cell. Garland Publishing, Inc. New York.

3. Wolfe, S.L. 1993. Molecular and cellular biology. WodsworthPublishing Company, California, U.S. A.

4. De, D.N. 2000. Plant cell vacuoles. An introduction. CSIRO Publication,Collingwood, Australia.

5. Kleinsmith, I.J. and Kish, V.M. 1995. Principles of Cell and MolecularBiology (End Edition). Harper Collins College publishers, New York, U.S.A.

6. Lpdish, H., Berk, A., Zipursky, S.Z., Matsudaira, P., Baltimore, D. and Darnell,J., 2000. Molecular Cell Biology. (4^{th}Edition). W.H. Freeman and company, New York, U.S.A.

Review Journals

1. Annual review of plant physiology and molecular biology.

2. Current advances in Plant Sciences.

3. Trends in Plant Sciences.

4. Nature reviews: Molecular and Cell Biology.

Suggested Readings (For Course BOT401and 402 Practicals)

1. Click, B.R. and Thompson, J.E. 1998. Methods in Plant Molecular biology and biotechnology. CRCPress, BOCA RBTON Florida.

2. Glover, D.M. and Hames, B.D. (Eds.) 1995. DNA cloning I: A practical approach, Core techniques,first edition, TASIRL Press al Oxford University Press, Oxford.

3. Gunning B.E.S. and Steer, M.W. 1996. Plant cell biology, structure and function. Jones and BartletPublishers, Boston, Massachusetts.

4. Hackett, P.B., Funchs, J.A. and Messing, J.W. 1998. An Introduction to recombinant DNAtechniques: Basic experiments in gene manipulation. The Benjamin Cummings PublishingCompany, Inc. Memno Park, California.

5. Hall, J.L. and Moore, A.L. 1983. Isolation of membranes and organelles from plant cells. AcademicPress, London, U.K,

6. Harris, N. and Opataks, K. J. 1994. Plant Cell Biology: A practical approach. IRL Press at OxfordUniversity Press, Oxford, U.K.

7. Shaw, C.H. (Ed.) 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.

BOT 403

(Biology and Diversity of Algae, Fungi and microbes)

UNIT- I. Algae:

- Introduction of phycology with special reference to Indian work.
- Algae in diversified habitats (Terrestrial, fresh water, marine)
- Criteria used in classification of algae, pigments, reserve food and flagella; and important systems of classification of algae.
- A general account of thallus organization, reproduction and life history of algae.
- Study of important groups of algae with reference to General account, cell structure and method of reproduction in
    - **Cyanophyta -** *Nostoc* and *Oscillatoria.*
    - **Chlorophyta**- salient features of Volvocales, Oedogonials and zygnematales (Desmids)
    - **Xanthophyta -** *Botridiuim, vaucheria.*
    - **Bacillariopyta -** *Diatoms.*
    - **Phaeophyta -** *Ectocarpus*.
    - **Rhodophyta -** *Batrachospermum.*
- Algal blooms, Role of Algae in human welfare, bio fertilizer.

UNIT- II. Fungi:

General Characters, Classification.

- Economic importance of fungi in medicine, Agriculture (Biopesticide an biofertilizer), food (SCP. Mushrooms)
- Fungi as plant pathogen – General account of different groups and type study of fungi as pathogen.
    - Mastigomycotina - *Phytophora, albugo,*
    - Zygomycotina –*Rhizopus*,
    - Ascomycotina – *Claviceps, Erysiphae,*
    - Basidiomycotina – *Puccinia, Ustilago,*
    - Deuteromycotina – *Alternaria, Fusarium, Cercospora, Helminthosporium*.

UNIT- III. Bacteria:

General characters, ultrastcture, classification, koch's postulates, archaebacteria and eubacteria.

- Role of agrobacterium in GM crops.
- Citus canker.
- Angular leaf spot of cotton.

UNIT- IV. Phytoplasma: General Account, ultrastructure and economic importance

- Grassy shoot of sugarcane.
- Little leaf of brinjal.

UNIT- V. Viruses: General account, ultrasturcture and economic importance of viruses.

- TMV
- Papaya leaf curl.

Practicals: Based On BOT 403

(Biology and Diversity of Algae, Fungi and microbes)

Algae:

01. Collection and study of algae from different localities, Identification up to generic level.

02. Morphological study of algal forms: *Microsystis, Oscillatoria, Lyngbya, Nostoc, Anabacna,Scytonema, Tolypothrix, Rivularia, Gloeotrichia, Cahthrix, Chlamydomonas, Pandorina, Eudorina, Volvox, Hydrodictyon, Scenedesmus, Pedistruium, Ulothrix, Ulva, Odeogonium, Cladophora, Pithophora, Draparnaldia, Draparnidiopsis, Coleochaete, Cosmarium, Closterium, Caulerpa, Acetabularia, Chara, Nitella, Botrydium, Vaucheria, Pinnularia, Navicula, Fragillaria, Ectocarpus, Diciyota, Fucus, Batrachospermum, Polysiphonia, Corallina.*

Fungi and microbes:

01. Principal and working of instruments.

02. Preparation of Media, strains and Isolation of Bacteria and Fungi from soil and infected plant tissues and pure culture.

03. Gram staining of bacteria.

04. Morphology and Taxonomy of following fungi - *Albugo, Phytophthora, Mucor, Rhizopus, Plasmopara, Sclerospora, Taphrina, Phyllochora, ClavicepsChaetomium, Puccinia, Ustilago, Sphacelotheca, Agaricus, PotyporusVolveriella, Cyaihus, Lycoperdon, Geaster, Alternaria, Aspergillus, Penicilliuin, Helminthosporium, Cercospora, Curvularia, Fusarium, Rhizoctonia, Coltetotrichutn, Phoma.*

05. Growth of Fungi on liquid and solid media — *Fusarium* and *Helminthosporium.*

06. Study of bacterial plant diseases - Citrus canker, Angular leaf spot of cotton, soft rot of fruits.

07. Study of Phytoplasma diseases - Little leaf of brinjal, Sesamumphyllody, Grassy shoot of sugarcane.

08. Study of viral plant diseases - Papaya mosaic, Tomato leaf curl, Yellow vein mosaic of Bhindi.

09. Collection and submission of fungal, viral, phytoplasma and bacterial diseases of plants.

Suggested Readings on BOT 403 Algae:

1. Chapman V.J. & DJ. Chapman (1983) The Algae, The MacMillan Press Ltd., London.

2. Desikachary T.V. (1959) Cyanophyta, 1CAR, New Delhi.

3. Fritsch F.E. (1961) The Structure and Reproduction of the Algae, Vol. I & H, CambridgeUniversity Press, London.

4. KumarH.D. (1988) Introductory Phycology, Affiliated East-West Press Pvt. Ltd., New Delhi.

5. Prescott G. W. (1969) The Algae: A Review, Thomas Nelson .and Sons Ltd., Melbourne.

6. Round F.E. (1981) The Ecology of Algae, Cambridge University Press, London.

7. Smith G.M. (1950) The fresh water algae of the United states, McGrawIIill Hoc Co., New York.

8. Vijayraghavan&SunitaKumari (1995) Chlorophyta, Bisen Singh M. P. Singh, Dehra Dun.

Suggested Readings — (Fungi and microbes)

1. U. Sinha and SheelaShrivastava (1985) An Introduction to Bacteria, Vikas Publishing House Pvt. Ltd., New Delhi.

2. Burgey's Manual of Systematic Bacteriology, Vol. 1-4(1986-1989) Williams & Wilkins, Baltimore.

3. J.P, Verma (1992) The Bacteria, Malhotra Publishing House, New Delhi,

4. A.J. Salle (1974) Fundamental Principles of Bacteriology, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

5. K.G.Hardy (1987) Plasmids - a Practical Approach, 1RL Press, Oxford, Washington D.C.

6. Bruce A. Voyles (2002) The Biology of Viruses, McGraw Hill, Boston.

7. LuriaS.E., J.E. Darnel!, D. Baltimore & A. Campbell (1978) General Virology, John Wiley *& Sons,* New York.

8. E.W. Mester, C.E. Roberts, M.M. Pearsall and B. J.McCarth- General Microbiology, Holt, Renehart& Winston, New York.

9. Powar&Daginawala (2004) General Microbiology Vol. II, Himalaya Publishing House, Mumbai.

10. R,F. Boyd (1984) General Microbiology, Times Mirror/Mosby College Publishing St. Louis.

11. S.B. Biswas & .Amrita Biswas (1993) An Introduction to Viruses, Vikas Publishing House Pvt. Ltd., New Delhi.

12. V.K. Gupta & M,K. Behl (1994) Indian Plant Viruses & Mycoplasma, Kalyani Publishers, Ludhiana.

13. S.P. Raychoudhari& T. K. Nariani (1977) Virus & Mycoplasma Diseases of plants in India, Oxford & IBH Publishing Co., New Delhi.

14. K.B. Deshpande& P.B, Papadiwal (1979) A Laboratory course in Bacteriology, COSIP- ULP - Botany Publication, Marathwada University, Aurangabad.

15. P.B. Papdiwal (1980) Biotechniques, COSIP- ULP - Botany Publication, Marathwada University, Aurangabad.

16. Alexopoulous C.J., C.W.Mims& M. Blakwel (1996) - Introductory Mycology, John Wiley & Sons Inc.

17. Dube H.C. (1994) - An Introduction to Fungi ,Vikas Publishing House, New Delhi.

18. Sharma P.O. (2000) - Microbiology and plant pathology, Rastogi Publication, New Delhi.

19. Mukadam D.S. (1997) 'The Illustrated Kingdom of Fungi', Aksharganga Publication, Aurangabad.

20. Mukadam D. S. (2004) - Modern Topics in Fungi, Saraswati Printing Press, Aurangabad.

21. Rangaswaini G. & A. Mahadevan (2001) - Diseases of Crop Plants in India., Prentice Hall of India, New Delhi.

BOT 404

(Taxonomy of Angiosperms)

UNIT- I: Angiosperms: Definition, its characteristic features and probable causes of theirevolutionary success. Taxonomy: Definition, scope, principles, aims and objectives oftaxonomy. History of Botanical Explorations in Maharashtra with special reference to Marathwada.

UNIT- II: Phylogeny of Angiosperms: A general account of origin of Angiosperms with reference to timeand place and possible ancestors: euanthial theory (Bennettitales, Caytoniales, Cycadales)and pseudanthial theory (Pentoxylales, Glossopteridae).

UNIT- III: Criteria used for classification; phases of plant classification and brief history on account ofartificial, natural, phylogenetic systems of classifications with special reference to Benthamand Hooker, Cronquist'ssystem, Takhtajan's system and Broad outline of APG III (2009) system of classification and itsmerits and demerits.

UNIT-IV: Botanical Nomenclature: Concept of nomenclature, Binomial nomenclature and itsadvantages, formation of code, Melbourne Code 2011, Principles of International Code of Nomenclature of Algae, Fungi and Plants (ICN), ending of taxa names, Typification.Taxonomic literature: Flora, manuals, monographs, periodicals, dictionaries, indices,journals, pictorial encyclopedias and books.

UNIT-V: Taxonomic evidences: Morphology, anatomy, embryology, palynology, cytology, phyto-chemistry and numerical taxonomy. Taxonomic tools: Serological and moleculartechniques, GIS, GPS, Use of computers in angiosperms taxonomy (Use of computer anddata bases for identification of plants with the help of website). Herbarium Techniques,Major herbaria of the World and India. Contributions of Herbarium BAMU.

UNIT-VI: Causes of variations in population; Speciation, Species Concepts; Taxonomic Hierarchy.

UNIT-VII: Angiosperm Families: Nymphaeaceae, Hydatellaceae, Magnoliaceae, Papaveraceae, Malvaceae, Sapotaceae, Apiaceae, Asteraceae, Arecaceae and Poaceae.

Practicals Based on BOT-404

TAXONOMY OF ANGIOSPERMS

1. Morphology: Terminologies related to Habit and life span, root, stem, leaves, inflorescence,Flower, fruits.
2. Phytography: preparation of scientific botanical description of a plant specimen.
3. Study of at least 20 locally available families of flowering plants.
4. Identification of genus and species of locally available wild plants.
5. Preparation of botanical keys at generic level by locating key characters.
6. Knowledge of at least 10 medicinal plant species.
7. Demonstration of the utility for secondary metabolites in the taxonomy of someappropriate genera.
8. Field trips within and around the University Campus, compilation of field notes andpreparation of herbarium sheets of plants.
9. Botanical excursion of about one week duration to any botanically rich location preferableoutside the State.

Suggested Readings

1. Cole, A.J. 1969. Numerical Taxonomy. Academic Press. London.
2. Daris, P.H. and Heywood, V.H. 1973. Principles of AngiospermsTaxonomy. Robert E.KriegerPub. Co. New York.
3. Grant, V. 1971. Plant Speciation, Columbia, University Press, New York.
4. Grant, W.F. 1984. Plant Biosystematics, Academic Press, London.
5. Harrison, H.J. 1971. New concepts in Flowering Plant Taxonomy. Hieman Educational Book Ltd.,London.
6. Heslop-Harrison, J. 1967. Plant Taxonomy. English Language Book Soc. & Edward Arnold Pub.Ltd. U.K.
7. Heywood, V.H. and Moore, D.M. 1984.CurrentConcepts in Plant Taxonomy, Academic Press,London.
8. Jones, A.D. and Wilbins, A.D. 1971. Variations and Adaptions in Plant species. Hieman&Co.Educational Ltd. London.
9. Jones S.B. Jr. &Luchsinger,A.E. 1986. Plant Systematics, (2nd Edition) McGraw-Hill Book Co. NewYork.
10. Radford, A.E. 1986 Fundamentals of Plant Systematics. Harper & RawPublications, U.S.A.
11. Soibrig. O.T. &Solbrig D.J. 1979. Population Biology andEvolution. AddisonwesleyPublicating Co. Inc.U.S.A.
12. Stebbins, G.L. 1974 Flowering Plant- EvolutionAbove Species Level. EdwardArnold Ltd,.London.
13.Stace,C.A. 1989. Plant Taxonomy and Biosystamatics. (2nd Edition)Edward Arnold,, London.
14. Takhtajan A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press,New York.
15. Woodland D.W. 1991. Contemporary Plant Systematies.Prentice Hall, New Jersey.

Semester-II

BOT 405

Cytology and Genetics

Unit I. Chromatin organization:

i. Chromosome structure and packaging of DNA.
ii. Nucleosome organization, DNA Structure (A, B and Z forms)
iii. Organization of centromere and telomere.
iv. Karyotype analysis and the banding patterns.
v. Special types of chromosomes- Polytene, Lampbrush, B-chromosome and sex chromosomes.
vi. Molecular basis of chromosome pairing.

Unit II. Structural and Numerical alterations in chromosomes:

i. The origin, meiosis and breeding behaviour of duplication, deficiency, inversion, translocation heterozygotes, haploids, aneuploids and autopolyploids.

ii. The allopolyploids and evolution of major crop plants.

Unit III. Mutation:

i. Spontaneous and induced mutations.

ii. Physical and chemical mutagens.

iii. Molecular basis of gene mutations.

iv. Transposable elements and mutation induced by transposons.

v. Site directed mutagenesis.

Unit IV.DNA damage and repair mechanism.

i. DNA damage and repair mechanism.

ii. Initiation of cancer at cellular level. Proto-oncogenes and oncogenes.

Unit V. Cytogenetics of aneuploids and structural heterozygotes:

i. Effect of aneuploids on plant phenotypes.

ii. The use of monosomics and trisomics in chromosome mapping of diploid and polyploid species.

iii. The breeding behavior and genetics of structural heterozygotes.

iv. The complex translocation heterozygotes.
v. Robertsonian translocation.
vi. B-A translocation.

Unit VI. Genetics of prokaryotic and eukaryotic organelles:

i. **Phage and Bacterial Genetics** —mapping of the bacteriophage genome, genetic recombination in phage, transformation, transduction and conjugation in bacteria

ii. Genetics of mitochondria and chloroplast, cytoplasmic male sterility.

iii. Gene fine structure. Cis-trans test, introns and their significance, RNA splicing.
iv. Regulation of gene expression in prokaryotes and eukaryotes.

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Practical Based on 405

1. Induction of polyploidy in plants using colchicine. Different methods of application of colchicine.
2. Isolation of biochemical mutants following physical and chemical mutagenic
3. Isolation of chlorophyll mutants following physical and chemical mutagenic treatments.
4. Isolation of morphological mutants following physical and chemical mutagenic treatments.
5. Karyotype analysis in any two plant species.
6. Meiosis of complex translocation heterozygotes.
7. Meiotic behaviour of monosomy in plants & its effect.
8. Meiotic behaviour of trisomy in plants and its effect.
9. Mitotic/ meiotic chromosomal behaviour in mutagen treated materials.
10. Orcein and Feulgen staining of the polytene chromosomes of Chironomus.
11. Study of chromosome pairing and disjunction in translocation heterozygote.
12. Utilization of banding technique for identification of chromosomes in karyotype.

Suggested Readings :

1. Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J. D. I989. Molecular Biology (Ed.) Garland Publishing Inc. New York.
2. Atherly, A. G., Girton, J. R. and McDonald, J. F. 1999. The Science of Genetics. Saunders College USA.
3. Burnham, C. R. 1962. Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.
4. Busch. H. and Rothblum, L. 1982 Volume X. The cell nucleus: DNA part A, Academic Press.
5. Hartl, D. L. and Jones E. W. 1998. Genetics: Principles and Analysis (4^{ih} Ed.) Jones and Barew Publishers, Massachusetts, USA.
6. Khush, G. S. 1973. Cytogenetics of Aneuploids, Academic Press, New York, London.
7. Karp, G. 1999. Cell and Molecular Biology; Concepts and Experiments, John Wiley and Sons Inc. USA.
8. Lewin, B. 2000. Genes VII. Oxford University Press, New York, USA. Lewis, R. 1997. Human Genetics: Concepts and applications (2^{nd} Ed),WCB, McGraw Hill, USA.
9. Malacinski, G. M. and Friefelder, D. 1998. Essentials of Molecular Biology (3^{rd} Ed.), John and Bartlet Publishers Inc. London.Russel, P. J. 1998. Genetics (5^{th} Ed) The Benjamin / Cummings Publishing Company, Inc. USA.
10. Snustad, D. P. and Simmons, M. J. 2000. Principles of Genetics (2^{nd} Ed.), John Wiley and Sons Inc. USA.

BOT 406

Plant Development & Reproduction

Plant Development

Unit I. **i. Meristems:** Organization of shoot and root apical meristem, various theories, Cytological and Molecular analysis of SAM, control of tissue differentiation especially Xylem and Phloem.

ii. Tissue systems: Differentiation and functions of different tissue systems such as epidermis, parenchyma, chlorenchyma, sclerenchyma, laticifers and glands.

Unit II. **i. Vascular tissues:** Origin, structure and functions Xylem and Phloem elements and their taxonomic significance, Wood development in relation to Environment.

Unit III. **i. Leaf:** Growth and differentiation, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.

ii. Root: Initiation and development; lateral roots, root hair, root microbe Interaction.

Plant Reproduction

Unit IV. i. **Flower:** Structure and development

ii**Pollination:** Types of pollination, attractions and rewards of pollination, pollination mechanism and vectors, breeding systems, structure of pistil, pollen interaction and fertilization.

Unit V. **i. Male gametophyte:** Structure of anthers, micro-sporogenesis, role of tapetum, male sterility, pollen germination, pollen tube growth and development, pollen storage, pollen allergy, pollen embryos.

ii. Female gametophyte; Ovule development, magasporogenesis, organization of the embryo sac. Structure of the embryo sac.

Unit V. **i. Seed development and fruit growth:** Double fertilization,Endosperm development, Embryogenesis, Ultra-structure and nuclear cytology; Development of dicot and monocot embryos, poly-embryony, apomixes, embryo culture.

Practicals Based on BOT-406

1. Dermatology - trichomes and stomata and leaf anatomy of *Nerium,Terminalia*etc.
2. Mechanical tissues (Collenchyma, Sclerenchyma, Stone cells and Xylem) , Secretary tissues (Mucilage Canals, Resin canals, Nectaries, and oil glands), laticifers (Latex cells and Vessels).
3. Vascular tissues and its constituents by sections and maceration, wood anatomy, TS, TLS and RLS
4. Abnormal secondary growth in *Dracaena, Bignonia, Aristolochia, Achyranthus, Nyctanthus, Salvadora, Beta, Mirabilis, Tinospora.*
5. Study of microsporogenesis and gamtogenesis in sections of anthers.
6. Examination of modes of anther dehiscence and collection of pollen grains for
7. Microscopic examination (maize, grasses, *Crotolaria, Tradescantia, Brassica, Petunia, Solanum*etc.)
8. Test for pollen viability using stains and *in vitro* pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
9. Estimation of percentage and average pollen tube length *in vitro*
10. Pollen storage, pollen pistil interaction, *in vitro* pollination.
11. Study of ovules and embryo sacs.
12. Field study of types of flowers and pollination mechanism. .
13. Study of nuclear and cellular endosperms.

Suggested readings

Burjes, J. (1985). "An Introduction to Plant cell development Cambridge University Press, Cambridge.

Carlquist S (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.

Chopra, V.L. (2001), 'Plant Breeding, Field Crops', Oxford, BH Pvt. Ltd, New Delhi.

Chopra, V.L. (2001), 'Plant Breeding; theory and practice', Oxford I BH Pvt. Ltd.

Cutler DF (1978). Applied Plant Anatomy, Longman, United Kindom

Cutter EG (1978) Plant Anatomy, Part I & II, Edward Arnold, United Kingdom.

Cutter, E.G. 1978 Plant Anatomy - Experiments and interpretations' Part I and II, Edward Arnold

Dickinson WC (2000).Integrative Plant Anatomy, Harcourt Academic Press, USA.

Esau, K, 1965. "Plant Anatomy" (Second edition; 7th reprint 1991), Wiley Eastern, New Delhi.

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Richards AJ (1986) Plant Breeding System, George Allen and Unwin.

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Shivanna KR (2003) Pollen Biology and Biotechnology, Science Publishers.

Shivanna, K.R. and John, B.M. (1985), 'The angiosperm pollen structure and function', Willey Eastern Ltd., New York.

Shivanna, K.R. and Rangaswamy, N.S. (1992), 'Pollen Biology: A laboratory manual', Springer Verlag, Berlin.

Shivanna, K.R. and V.K. Sarobney, (Ed) 'Pollen Biotechnology for crop production and

Sleeves, T.A. and Sussex, LM.1989, 'Patterns in plant development *(*7^{th}edition) Cambridge Press, Cambridge.

BOT 407

Biotechnology

Unit I.Biotechnology: Basic concept, Historical, principles of tissue culture, Cellular totipotency, Discoveries of Plant Growth hormones in brief review, Contribution of Sir Gottlieb Haberlandt, Development of Tissue culture as a technique, Scope and Importance.

Unit II.Introduction to tissue culture: Tissue culture laboratory, Equipment's in Tissue culture laboratory, Preparation of Media, Media composition, Plant Growth Regulators and their Role, selection of media for specified applications, Selection of explant, Sterilization, Sterilizing agents, initiation of tissue culture

Unit III. Cellular totipotency: Media for initiation of callus, dynamics of callus growth, measurement of growth, organogenesis and factors controlling it, genome instability in reaction to morphogenesis, somaclonal variation and its applications.

Unit IV. Cell and organ culture: Plant organ culture; shoot tip, shoot apical meristem, root, leaf, flower and ovary culture, embryo rescue, factors influencing embryogenesis, suspension culture in stationary and stirred tank reactors, isolation of single cells and their culture, measurement of growth,

Unit V.Practical approaches of single cell culture: Somatic embryogenesis, protoplast isolation, regeneration of protoplasts and protoplasts fusion, Synthetic seeds, generation of cybrid and hybrids, cryopreservation of plant cells.

Unit VI. **Applications of tissue culture:** Applications in agriculture and Horticulture, Application in Forestry, Application of Tissue culture in pharmaceutical industry. *In situ* and *ex-situ* conservation.*In vitro* mutagenesis and its application. Production of transgenic plants

Unit. VII. Recombinant DNA technology: Gene cloning, Vectors, Role of *Agrobacterium*, Gene cloning techniques - Gene gun, Electroporation, Microinjection, Liposome mediated gene transfer, Ultra sonication and Pollen Mediated gene transfer.

Practicals based on 407

1. Equipment's required in Tissue culture Lab
2. Media preparation
3. Sterilization of media
4. Sterilization of explant.
5. Explant Culture.
6. Anther culture
7. Pollen culture,
8. Micropropagation.
9. Embryo rescue technique.
10. Somaclonal variation.
11. *In vitro* mutation.
12. Isolation of plant protoplasts and viability testing.
13. Protoplast fusion by PEG.
14. Tissue culture of Horticultural plant Banana.
15. Tissue culture of Medicinal plant.

Suggested readings:

1. Henry, R.J. Practical application of plant molecular Biology, Champman and Hall
2. Kalyankumar De. Introduction to Plant Tissue culture,
3. Bhojwani, Plant Tissue Culture.
4. Montell S.H. Mathews, J.A., Meker, R.A. Principles of Plant Biotechnology.
5. Glover, D.M. and Hanes, B.D. (eds.) 1995. DNA cloning 1: A practical approach, core techniques , 2nd edition, PAS, IRL press at Oxford University Press.
6. Plant cell culture protocols. Humana Press, Inc. New Jersey, USA.
7. Shaw, C.H. (ed.) 1998, Plant Molecular Biology. A practical approach IRI Press, Oxford.
8. Smith, R.H. 2000. Plant Tissue culture: Techniques and Experiments. Academic Press, New York.
10. Susan R. Barnum (1998). *Biotechnology: an introduction*. Thomson Brooks/cole.
11. George Acquaah (2005). *Understanding biotechnology*. Pearson.
12. Biotechnology; P.K. Gupta

BOT 408

Plant Physiology and Metabolism

Unit I. Plant water relations: Water Potential, Absorption and Transpiration, Stomatal Physiology, Active and passive transport of solutes, Phloem loading and unloading, source-sink relationship, Physiology of plants under water stress.

Unit II. Enzyme: Nomenclature, Properties and classification of enzymes, Mechanism of Enzyme action, regulation of enzyme action, isoenzymes.

Unit III. Photosynthesis: Light and dark reactions, pigments and mechanism of light absorption, Photosystem I and II, Emerson enhancement effect, C3, C4 and CAM pathways, significance of C4 and CAM pathways, photorespiration, Photo synthetic productivity.

Unit IV. Respiration: Glycolysis, TCA cycle and its role in synthesis of bio-molecules Mitochondrial electron transport, oxidative phosphorylation, Pentose phosphate pathway, cyanide resistance, Bioenergetics principles.

Unit V. Nitrogen Metabolism: Nitrification and denitrification, Nitrate assimilation, Biological nitrogen fixation, Biosynthesis of amino acids - reductive animation and trans amination, Protein synthesis, classification of amino acids and proteins, amphoteric nature and zwitter ions, structure of proteins, protein denaturation, Isolation and purification of proteins.

Unit VI. Lipid Metabolism: Fatty acids, lipids, triglycerides, Saponification, oxidation of Fatty acids- alpha and beta oxidation.

Unit VII. Plant Growth: Growth curve, growth analysis, plant growth regulating substance (PGRS), Gibberellins, Cytokinesis, Abscisic acid, Ethylene, role of PGRs in agriculture.

Unit VIII. Plant Development: Physiology of flowering, Phytochrome, flowers induction, Seed germination and dormancy, senescence and aging, stress physiology, vernalization and abscission.

Practicals Based On BOT- 408

1. Separation of chlorophyll pigments by paper and thin layer chromatography,
2. Spectrophotometry - Absorption spectrum for chlorophyll pigments extracted from green leaves.
3. Estimation of total chlorophyll, chlorophyll 'a' and chlorophyll b
4. Estimation of reducing sugars using Fehling's solution A and B.
5. Isolation of starch from potato.
6. Isolation of pectin form fruit rinds.
7. Hydrolysis of starch by acid and crude enzyme extract from germinating seeds.
7. Effect of temperature on permeability.
8. Difference between C3 and C4 plants- chlorophyll content and leaf anatomy.
9. Estimation of Ascorbic acid from fruit juice and germinating seeds.
10. Estimation of proline in normal plant and that under stress.
11. Separation of amino acids by paper and thin layer chromatography.
12. Chemical tests for protein.
13. Estimation of protein by Lawry's method.
14. Estimation of protein by Biuret method.
15. Isoelectric point of casein.
16. Immobilization of enzymes using sodium alginate.
17. Preparation of leaf protein concentrate (LPC) by heat coagulation method.
18. Iodine number of fat.
19. Saponification number of fat.
20. Growth analysis - RGR, NAR and LAI.
21. Biostatistics: mode, median, mean, range, mean deviation, standard deviation, coefficient of variation (C.V.) in simple or classified data (frequency distribution).

Suggested Readings :

1. Plant physiology: F.N. Salisbury and C.W. Ross, CBS Publishers and Distributors, New Delhi.
2. Principles of Biochemistry, A.L. Lehninger, CBS Publishers and Distributors, New Delhi.
3. Plant physiology: R.G.S. Bidwell, Mac Millan Publishers Co., New York.
4. Advnced plant physiology, M.B. Wilkins, English Language Book Society, London.
5. Principles of plant physiology, Bormer, J. and Galston, A.W.
6. Introductory plant physiology, Noggle G.R. and Fritz, G.S., Prentice Hall, USA.
7. Plant Water Relationships, Slyter, R.O. Academic Press, New York.
8. Plant physiology, D. Hess, Narosa Publishing House, New Delhi.
9. Elementary Biochemistry, Mertz, E.T. Vakils, Fetter and SimsonsPvt Ltd. Mumbai.

10. Essentials of Biological Chemistry, Fairley, J.L. and Kilgon, G.L., Earr west Press Pvt. Ltd., Delhi.

11. Plant physiology, Devlin, R.M. and Hostan, F.H., CBS Publishers and Distributors, New Delhi.

12. Plant Physiology, S.C.Datta, Willey Eastern Limited, Culcutta.

13. Plant Physiology, S. Mukharji, A.K.Ghosh, New Central Book Agencies, Kolkatta.

14. An Introduction to Biometry, A.M.Mungikar, Sarswati Printing Press, Aurangbad.

15. Biostatical Analysis, A.M.Mungikar, SarswatiPrinting Press, Aurangabad.

16. Laboratory Manual in Biochemistry, Jayraman, J., New Age International Publishers, Mumbai.

17. Experiment in Plant Physiology, D. BajrachrysNarosa Publishing House, New Delhi.

Semester-III

BOT 501: BIOLOGY & DIVERSITY OF BRYOPHYTES, PTERIDOPHYTES & GYMNOSPERMS

Unit I. Bryophytes: Systems of classification, distribution, Economic importance. Habitat, external and internal morphology, reproduction, gametophytes and sporophytes,phylogeny and interrelationships of the orders: Sphaerocarpales, Takakiales, Marchantiales and Jungermanniales,Anthocerotales, Sphagnales, Andreales and Bryales.

Unit II. Pteridophyta: Classification, Origin and evolution,Phylogenetic relationship with Bryophyta. Morphology, anatomy, phylogeny and interrelationships of the orders Psilopsida-Psilotales and Psilophytales,Lycopsida- Lycopodiales, Selaginellales, Isoetales, Equisetopsida – Equisetales and Pteropsida- Filicales.

Unit III. Sporophyte and gametophyte in Pteridophytes,Stelar organization and evolution,Origin of leaf and Telome concept,Sporocarp,Heterospory and seed habit,Comparison of Pteridophyta with Bryophyta and Gymnosperms.

Unit IV. Gymnosperms: Introduction, Classification and distribution of Gymnosperms, Morphology, anatomy, reproduction, phylogeny of the orders Pteridospermales (Caytoniaceae, Medullosaceae)Bennettitales (Williamsoniaceae, Cycadeoideaceae)Cycadales (Cycadaceae)Ginkgoales (Ginkgoaceae) Coniferales (Pinaceae, Araucariaceae)Taxales (Taxaceae) Gnetales (Gnetaceae) and Economic importance of gymnosperms.

Unit V. Paleobotany: Introduction, Contributions of Prof. BirbalSahani, Geological time scale, Fossils and fossilization, Continental drift/ plate tectonics.

PRACTICALS BASED ON BOT 501: BRYOPHYTES, PTERIDOPHYTES & GYMNOSPERMS

i. **Vegetative Organization:***Marchantia, Riccia, Anihoceros, Sphagnum,Polytrichum.*

ii. **Anatomical Organization:** *Marchantia, Cyathodium, Anthoceros, Sphagnum.*

iii. **Archegonia and Antheridia and their Organization:***Riccia, Marchantia, Anthoceros,Sphagnum.*

iv. **Sporophytes***: Riccia, Marchantia, Pellia, Anthoceros, Funaria, Sphagnum,Polytrichum.*

Pteridophytes: Morphological and anatomical studies of1) *Psilotum*2) *Lycopodium.* 3) *Selaginella*, 4) *Isoetis*, 5) *Equisetum*,6) *Ophioglossum*, 7) *Osmunda*, 8) *Gleichenia*, 9) *Pteris*, 10) *Adianium*,11) *Marselia*, 12) *Salvinia*, 13) *Azolla*and additional forms/speciescollected during study tour.

Gymnosperms : Study of the vegetative and reproductive parts, including anatomy of thefollowing genera : *Cycas, Zamia, Pinus, Cedrus, Taxodium, Cryptomeria,Cupressus, Thuja, Juniperus, Podocarpus, Cephalotaxus, Agathis, Araucaria,Taxus, Ginkgo, Gnetum.*

SUGGESTED READINGS:

Agashe, S. N. (1995) Paleobotany, Oxford & IBH, New Delhi

Bir, S. S. (2005) Pteridophytes their Morphology, Cytology, Taxonomy and Phylogeny.Today & Tomorrow's Printers and Publisher.

Biswas, C. and B. M. Johri (2004) The Gymnosperms, Narosa Publishing House, New Delhi

Campbell, C. J. (1940) Evolution of land Plants, Stanford University Press.

Coulter J. M. and C. J. Chamberlain (1978) Morphology of Gymnosperms, Central Book Depot, Allahabad

Eames, A. J. (1974) Morphology of Vascular Plants- lower groups, Tata Me Graw-Hill Publishing Co. New Delhi.

Foster, A. S. & F. M. Gifford (1967) Comparative morphology of vascular plants, Freeman Publishers, San Fransisco.

Kakkar, R. K. and B. R. Kakkar (1995) The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad.

Kashyap S. R. (1932) Liverworts of Western Himalayas and the Plains.Vol. I & II, The University of Panjab, Lahore.

Parihar, N. S. (1991) Bryophytes, Central Book Dept., Allahabad.

Parihar, N. S. (1976) The biology and morphology of the pteridophyta, Central Book Depot, Allahabad.

PuriPrem (2005) Bryophytes Morphology, Growth and Differentiation- Pulisher- Atmaram and Sons New Delhi

Rashid, A. (1976) An introduction to pteridophyta, Vikas Publishing House Ltd., New Delhi.

SambamurtyA. V. S. S. , (2005) A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, Today & Tomorrow's Printers and Publishers

Sharma O. P. (2002) Gymnosperms, PragatiPrakashan, Meerut.

Sharma P. N. and Sahni K. C. (2005) Gymnosperms of India and Adjacent Countries Publisher-Bhishan Singh Mahendra Pal Singh, Dehradun

Tewari, Shiv Datt and GiriBala Pant (2005) Bryophytes of Kumaun Himalaya. Publisher-Bhishan Singh Mahendra Pal Singh- Dehradun

Siddiqui K. A. (2002) Elements of Paleobotany, KitabMahal, Allahabad.

Smith, G. M. (1976) Cryptogamic Botany - Vol. II, Tata Me Graw-Hill Publishing Co. Ltd. New Delhi.

Sporne, K. R. (1976) Morphology of Pteridophyta. Hutchinson University Library, London.

BOT 502: ECOLOGY & CONSERVATION

Unit I i. An introduction to plant ecology and its scope.

ii. **Structure of ecosystem:** Abiotic components (climatic factors, Topographic/factors, Edaphic factors); Biotic components (Interactions among organisms, Autotrophs and Heterotrophs) Ecological Pyramids (Pyramid of numbers, Biomass and energy)

iii.**Functions of ecosystem:** Productivity (Primary and secondary productivity, food chains, Grazing and detritus food chains) food webs. Biogeochemical cycles: C, N, P and S.

Unit IIi.**Community ecology:** Classification, Analysis of communities, characteristics of communities, species diversity, Growth form and structure, origin, development and composition.

ii.Competition and coexistence, intra-specific interactions, interspecific interactions, scramble and contest competition model, mutualism and commensalism,prey-predator interactions.

Unit IIi. **Biogeography:** Major biomes of the World -Terrestrial, Tundra, arboreal coniferous forests, temperate and tropical grasslands and deciduous forests, Mediterranean and Desert vegetation, Tropical rain forests; Aquatic Ecosystems- Fresh water, Estuarine and marine. Endemism and hotspots of biodiversity.

Unit IV.i. Environmental pollution in relation to air, water and soil. Use of fertilizer, pesticides andother chemicals in agriculture and hygiene and their disposal.

ii. Climate change:Greenhouse gases, their sources, trends and role, Ozone layer and its depletion (Global warming, Sea level rise, UV radiation) acid rain, Bioindicator and biomarkers of environmental health.

iii. Concepts of ecological management and sustainable development.

Unit V. i**.** Biodiversity: Concept, types and situation in India. IUCN categories.

ii. Strategies of conservation: *In situ* conservation, protected regions in India: Sanctuaries, National parks, Wetlands, Sacred groves, mangroves for conservation of wild biodiversity. *Ex situ* conservation: Principles and practices, Botanic gardens- Definitions, Criteria and types; Important Botanic Gardens in India and World, BGCI, gene bank, seed banks, cryobanks.

Unit VI.i. General activities of Botanical Survey of India (BSI) and National Bureau of plant Genetic Resources (NBPGR) for conservation efforts.

ii. Biological DiversityAct 2002; Forest Conservation Act 19, Wild Life Protection Act 1972 and relatedinternational conventions.

PRACTICALS BASED ON BOT 502: ECOLOGY & CONSERVATION

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use 't' test for comparing two means related to ecological data.
2. To find out relationship between two ecological variables using co-relation and regression analysis.
3. To find out association between important grassland species using chi-square test.
4. To determine minimum size and number of quadrates required for reliable estimate of biomass in grassland.
5. To determine diversity indices (Shannon-Wiever concentration of dominance) for protected and unprotected grass land stands.
6. To estimate IVI of the species in a wood land using point centerquadrate method.
7. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
8. To determine the water holding capacity of soils collected from different locations.
9. To estimate the DO content in water samples by Winkeler's method.
10. To estimate chlorophyll content in SO_2 fumigated and non-fumigated plant leaves.
11. Visits to different ecosystems and submission of report.
12. Scientific visits to laboratories / Industries / Research Institutes working in conservation of plants and submission of report.

SUGGESTED READINGS:

Ambasht, R. A. (1990) A text book of Plant Ecology, Students Friends & Co., Varanasi.

Benny Joseph (2005) Environmental Studies, Tata McGraw Hill Publishing Co., Ltd., New Delhi.

Conklin, A. R. Jr. (2004) Field Sampling: Principles and Practices in Environmental Analysis. CRC Press.

Fahey, T. J. and Knapp, A. K. (2007) Principles and Standards for Measuring PrimaryProduction. Oxford.

Grant, W. E. and Swannack, T. M. (2008) Ecological Modeling. Blackwell.

Koromondy, E. J. (2005) Concepts of Ecology.4th Ed. Prentice Hall of India, New Delhi.

Muller, Dombosis, D. and H. Ellenberg (1974) Aims and methods of vegetation ecology, Wiley, New York.

Mungikar, A. M. (2003) Biostatistial Analysis. Saraswati Printing Press. Aurangabad.

Odum E. P. (1971) Fundamentals of Ecology, Saunders, Philadelphia.

Rajagopalan, R. (2005) Environmental studies, Oxford University Press, New Delhi.

Ramkrishna, P. S. (2001) Ecology and Sustainable Development. National Book Trust, New Delhi.

Sharma, P. D. (2001) Ecology and Environment, Rastogi Publications. Meerut.

Stiling, Peter. (2004) Ecology- Theories and Applications.4th Ed. Prentice Hall of India, New Delhi.

Trivedi, P. R. (1999) Encyclopedia of Ecology and Environment. Vol. 1 - 10, Indian National Green Party, New Delhi.

Trivedi. R. K., Goel P. K., Trisal C. L. (1998) Practical Methods in Ecology and Environmental Science: Enviro-media Publisher, Karad

Wilkinson, D. M. (2007) Fundamental Processes in Ecology: An Earth system Approach. Oxford.

Wyse Jackson, P. S. and Sutherland, L. A. (2000) International Agenda for Botanic Gardens in Conservation, Botanic Garden Conservation International (BGCI) UK

Yadav, Manju (2003) Ecology. Discovery Publishing House, New Delhi.

WEBSITES:

www.nbaindia.org

www.envfor.nic.in

www.moef.nic.in

www.bgci.org.uk

www.bsi.nic.in

www.bsienvis.nic.in

www.nbpgr.ernet.in

www.maharashtrastatebiodiversityboard.gov.in

www.iucn.org

www.iucnredlist.org

www.iucnredlistecosystems.org

www.conservation.org

www.biodiversity-a-z.org

BOT-521- (Elective-A)

Crop genetics and Plant breeding-I

Unit I Crop genetic resources: Importance of genetic Conservation, global network for genetic conservation and utilization in major crops of the world. Institutes engaged in conservation and improvement of crop genetic resources.

Unit II Food supplies, nutrition and crop breeding: World food situation, nutritional problems, Nutritional objectives.

Unit III Methods of plant breeding: Introduction, selection, (Pure line selection, W. L. Johansons experiments on beans and their significance, Variety acclimatization, genetic significance of pollination methods, methods of breeding self and cross pollinated crops and asexually and vegetatively propagated crops.

Unit. IV Incompatibility in plant breeding: Types, nature, characteristics genetic and biochemical basis, methods of induction and overcoming, incompatibility as a tool in breeding crops.

Unit. V i. Male sterility: Definition and classification, Male sex expression and chemical Induction of male sterility, perspectives.

ii Back cross: Genetic basis, Methodology in selection to character under transfer, Transfer of two or more characters, Inter-varietal. Inter-specific and intergeneric transfer.

BOT- 521 – (Elective B)

Plant Pathology-I

Unit I. Plant disease diagnosis: Field observations, laboratory investigations, isolation of plant pathogen and purification, Koch's postulates; identification of plant pathogens.

Unit II Classification of Plant diseases: Based on crop plants, symptoms, causal organisms.

Unit III. Symptoms, etiology and disease cycle of diseases caused by:

a) **Mastigomycotina:** Damping off of seedlings, Rhizome rots of ginger, early blight of potato, white rust of crucifers, Downy mildew of Bajra, Downy mildew of grapes.

b) **Ascomycotina:** Stem galls of coriander, leaf spot of turmeric, powdery mildew of grapes, Ergot of bajra. .

Unit IV. Symptoms, etiology and disease cycle of diseases caused by

a) **Basidiomycotina:** Loose smut of wheat, Bunt of wheat, kernel bunt of Rice, Head smut of Jowar, grain smut of Jowar, whip smut of sugarcane. Rust: Rust of wheat, Rust of Bajra, Rust of groundnut

Unit V. Symptoms, etiology and disease cycle of diseases caused by Deuteriomycotina:

Early blight of potato and tomato leaf spot caused by *Alternaria* on brinjal, crucifers, Tikka disease of groundnut, Helminthosporiurn leaf spot on Rice; Blast of Rice, Red rot of sugarcane, Die back of chili, Wilt of Pigeaon pea, Panama disease of Banana, Blight of gram, *Rhizoctonia*stem rot of crops

BOT-521 (Elective C)

TAXONOMY OF ANGIOSPERMS-I

UNIT-I: **Characteristic features of angiosperms;** aims and objectives of taxonomy, functions and phases of taxonomy; taxonomy as synthetic discipline (passing remarks)

UNIT-II: **Phylogeny of angiosperms:** monophyletic and polyphyletic origin of angiosperms, herbaceous origin hypothesis, origin of monocotyledons; molecular evidence to angiosperm origin, cradle of angiosperms.

UNIT-III: **Taxonomic hierarchy:** it's major, minor and intraspecific categories and ranks

A brief history of Pre-Darwinian and post Darwinian systems of classification with special emphasis on Thorne and Cronquist's systems of classification

UNIT-IV: **Concept of taxonomic character:** analytical and synthetic, qualitative and quantitative, genetically and environmentally controlled, good and bad character, character weighing, taxonomic coefficient

UNIT-V: **Phylogenetic relationship:** Primitive and advanced characters, monophyletic, paraphyletic and polyphyletic, homology and analogy, parallel and convergent evolution, plesiomorphic and apomorphic characters. **Cladistics:** Operational Taxonomic Units (OTU) characters and coding, measuring of similarity, cladograms.

BOT 521 (Elective D)

Advanced Plant Physiology and Biochemistry-I

Unit I. Plant Composition : Structure and biochemical role of major plant constituents, carbohydrates and its derivatives, structure and classification of proteins, glycoproteins, peptidoglycans, lipids and glycoproteins, lipid and triglycerides, fatty acids, vitamins and nucleic acids.

Unit II. Pigments: chlorophylls, phycobiliproteins, phenolics, sterols, alkaloids, carotenoids, phytochrome, anthocyanine, phenolics, sterols, alkaloids, porphyrins, organic acids, possibilities of isolating these chemicals for human welfare.

Unit III.Principles and applications of colorimeters, photometry flame photometers, spectrophotometry, chromatography (ion exchange, affinity, thin layer, high pressure liquid) gel filtration, electrophoresis, electro focusing and ultracentrifugation,

Unit IV. Application of radioactive tracer technique in biology, radioactive isotopes

Autoradiography, Biophysical methods X ray diffraction, fluorescence UV, NMR and ESR Atomic absorption spectroscopy

Unit V. Growth analysis: Growth, growth curve, lag, log and senescence phase, growth rates AGR, RGR, NAR, LAP, LAI, CGR and LAD productivity potential of dwarf varieties, causes of dwarfism, morphological and physiological factors in relation to height. Yields of dwarf plants,

BOT 522 – (Elective –A)

Crop genetics and plant breeding - II

Unit I Heterosis breeding: i) Historical aspects, ii) Interbreeding depression, iii) Homozygous and heterozygous balance, iv) Genetic basis of inbreeding, v) Genetic and physiological basis of heterosis, vi) Heterosis and plant breeding.

Unit II Mutation Breeding: i) Historical perspective, ii) The nature and chemical basis of mutation, iii) Physical and chemical mutagenesis, iv) Mutagenic treatment schedules, v) Screening of mutation in population, vi) Frequency and spectrum of mutants, micro and macro mutants, vii) mutagenic effectiveness and efficiency, viii) environmental mutagenesis repair mechanism, ix) Role of mutations in crop improvement programme.

Unit III. i. Resistance breeding:

A. Disease resistance-nature, mechanism of resistance, methodology problems and achievements.

B. Insect resistance: Nature, mechanism of resistance, methodology, problem and achievements.

C. Drought resistance, importance, types, nature of resistance methods and examples.

ii. Quality breeding: A. Nature of quality B. Genetic and biochemical basis C. Genetic manipulation of quality and quantity.

Unit IV. Distant Hybridization: a) Importance, b) Interspecific, intergeneric gene transfers, methodology, problem and remedial measures, c) Man made species.

Unit-V i. Seed production and distribution: Introduction variety evaluation, variety maintenance, availability of new varieties, seed production and regulation, seeds industry development. Breeding crops with special reference to Marathwada region like wheat. Jowar, Bajra, Cotton, Groundnut, Safflower etc.

BOT- 522 – (Elective B)

Plant Pathology-II

Unit I. i. Agents of infections and diseases: Biotic agents - bacteria, viruses, fungi, mycoplasma, nematodes.

ii Abiotic agents: Air pollution; mineral elements, temperature, toxic effects of improperly used chemicals.

Unit II.Phytoplasma diseases: Symptoms and disease cycle of little leaf of brinjal; Sesamumphylody, witches broom diseases, Grassy shoot of sugarcane.

Unit III. Viral diseases: Symptoms produced by viruses on plants, study of plant virus disease; Tobacco moisac, leaf curl of tomato, papaya moisac, yellow vein moisac of bhendi, Bunchy top of Banana, Tristeza of citrus.

Unit IV. Bacterial diseases: symptoms of bacterial diseases on plants. Study of bacterial diseases: Angular leaf spot of cotton, citrus canker, Gummosis of sugarcane, Bacterial wilt of solanaceous vegetables. Halo blight of bean, Soft rots of fruits.

Unit V. Non parasitic diseases: Non infectious diseases of plants, Nutritional deficiencies, Blossom rot of tomato, mango black tip, zinc deficiency of citrus.

BOT-522 (Elective C)

TAXONOMY OF ANGIOSPERMS-II

UNIT-I: **The concepts of species;** plant speciation: allopatric/ abrupt/ sympatric/ hybrid/ apomictic speciation and isolation mechanism. Types of speciation: quantum, catastrophic, local, geographic and phyletic. Causes of variation in population, ecotypes and ecads, evolution and differentiation of species, adaptive radiations.

UNIT-II:**Botanical Nomenclature:** Scientific names: legitimate name, illegitimate name, autonym, homonym, synonym, basionym, tautonym, alternative name, ambiguous name, superfluous name, naked name, conserved name, rejected name; procedure to describe new taxon; Latin diagnosis and description, effective and valid publication, coining of generic names and specific epithets; citation of names of author(s) ; Scientific Journals in plant taxonomy.

UNIT-III: **Taxonomic evidences:** Morphology, micro-morphology, ultrastructure systematics- SEM and TEM studies, anatomy, embryology, palynology, cytology, ecology, population biology, phyto-chemistry, molecular biology and numerical taxonomy.

UNIT-IV: **Herbarium:** History, Objectives and function of an herbarium, Types of herbaria, role of herbarium in Systematics, Floristics, Teaching, Research, Assessment and documentation of phyto diversity and Public Education, pests in herbarium and its control.

UNIT-V: Comparative account on distribution, floral morphology, interrelationships of families belonging to the following order as per Engler's system of classification:

a) Magnoliales, b) Alismatales, c) Liliales, d) Asparagales,
e) Poales, f) Zingiberales g) Ranunculales h) Malphighiales
i) Fabales j) Cucurbitales

BOT 522 (Elective D)

Advanced Plant Physiology and Biochemistry - II.

Unit I Photosynthesis and plant productivity C3, C4 and CAM pathways and photorespiration in relation to crop productivity, soil and water conservation methods, weed biology herbicides, biological weed control, intensive cropping, zero tillage use of plant growth regulators and bio-fertilizers in agriculture, Nitrogen use efficiency, optimum economic dose of nitrogen fertilizers green manuring.

Unit II Biomass : The concept of Biomass, Biomass production, Utilization of biomass as a energy agricultural. Residue and their management HDEF energy forests energy crapping hydro carbon, plants biomathylation biogas, biogas plants, biogas production from soils city wastes.

Unit III.The practice of green manuring and preparation of compost NADEP and other methods, Utilization of solid wastes for composting recent trends in solid waste management and production sources.

Unit IV. Green crop fraetionation: The GGF system and advantages of GCF. Mechanical fractionation, plants suitable for GCF, Machinery recommended for mechanical fractionation, products, pressed crop residue (PCR) Juice, leaf protein concentrate and deproteinized Juice (DPJ)

Unit V. Green Crop Fractionation: Use of PCR in animal nutrition preparation of silage, silage fermentation, use of leaf juice as a milk replacer, Preparation of LPC, chloroplastic and cytoplasmic LPC, Nutritive value of LPC, and its suitability in human nutrition as a sources of protein and vitamin - A, preservation of LPC, DPJ as a replacer of tissue culture media, LPC compared with algal protein SCP, the possibility of increasing protein productivity through green crop fractionation. Bidkin Process.

Practicals Elective -1 course – BOT 521 and BOT 522 (Elective A)

1. Study of floral biology of different crop plants.
2. Demonstration of hybridization technique in self and cross pollinated crops.
3. Study of pollen germination and demonstration of incompatibility.
4. Demonstration of male sterility in Jowar.
5. Study of pollen fertility.
6. Study of pollen viability.
7. Karyotype analysis in crop plants.
8. Aneuploid analysis in crop plants.
9. Induction of polyploidy in crop plants.
10. Study of seed protein profile by native and SDS-PAGE.
11. Estimation of oils from edible oil crops.
12. Estimation of leaf proteins, seed proteins in diploids and polyploids.
13. Mutagenesis**:** Introduction of mutations through physical / Chemical mutagenic treatments and raising M_1 & M_2 generations. Assess in the effect of mutagens on different M_1 parameters and M_2 chlorophyll viable mutant frequency and spectrum.
14. Study of mutagenesis data published in different journals and arriving at logical conclusions by providing theoretical reasons.
15. Designing of filed experiments.

Suggested readings

1. Plant Breeding - B. D. Sitigi.
2. Plant Breeding - J. R. Sharma.
3. An Introduction of plant breeding - H. K. Chaudhary.
4. Evolution of crop plants -Edited by Simmonds N. W (1986)
5. Breeding field crops - Poehlrnann and Sleper.
6. Plant Breeding perspectives - Edited by Sheep and Mendnkasen.
7. Crop Breeding, P. B. Vose and S. G. Blixt
8. Genes. Chromosomes and Agriculture.Chrispels and Simmonds.
9. Principles of Genetics - Snusted and Simulants.
10. Manual of mutation breeding by FAO/IAEA.
11. Mutation Research -Aurebach.
12. Chemical mutagenesis - Fishbeiri et al.
13. Discussions in cytogenetics. Burnhan C. R. 1962 -
14. Genetics - Principles and analysis. Khush G. S. 1973 -
15. Genetics Principles and analysis. Haiti and Jones 1998 -
16. Molecular biology of the gene. Watson J. D. 1989

Practical Course based on BOT 521 and BOT 522 (Elective B)

1. Collection and preservation of diseases specimens.
2. Symptomology, histopathology of disease given in theory.
3. Virulence test for pathogens.
4. Visits to fields for study of diseases.

Suggested readings

1.Agrios, G. N. (1969) Plant Pathology, Academic Press, New York.

2. Rangaswami, G. and A. Mahadevan (2001) Disease of crop plants in India, Prentice Hall of India, Pvt. Ltd., New Delhi.

3.Gupta, V. K. and V. S. Paul (2001) Disease of vegetable crops. Kalyani Publ. Ludhiana,

4. Gupta, V. K. and S. K. Sharma (2000) Disease of fruit crops, Malyani Publ. Ludhiana.

5. Raychaudhari, S. P. and T. K. Nariani (1977) Virus and Mycoplasma disease of Plants in India. Oxford and IBK Publ. Corp., New Delhi.

6. Bos, L. (1999) Plant viruses, unique and intriguing pathogens. Backhugs Publ. Leiden.

7. Rangaswami, G. and S. Rajagopalan (1973) Bacterial Plant Pathology, T. N. Agri. Uni., Coimbatore.

Practicals based on BOT-521C & BOT-522 (Elective C)

TAXONOMY OF ANGIOSPERMS I & II

1. Description of species based on many specimens to study intraspecific variation.
2. Study of morphology and general evolutionary trends in flowers, stamens and carpels of primitive families viz. Magnoliaceae, Papaveraceae, Nymphaeaceae, Lauraceae
3. Study of different types of ovules, placentation and evolutionary trends therein
4. Exercises on nomenclature problems: Author citation, principle of priority, transfer of taxa, effective and valid publication.
5. Describing new taxon, deposition of type, Latin diagnosis and abbreviations used in citations.
6. Semi-permanent pollen preparations by acetolysis method and study of different pollen morphotypes.
7. Taxonomic distribution of special units of pollen dispersal- bi celled pollen, tetrads, polyads and pollinia and pollen types.
8. Study of plant surface attributes with the help of SEM photographs.
9. Descriptions, sketching, classification and identification of at least 30 families represented in local flora.
10. Classification and identification of at least 5 species of some of the genera like *Alysicarpus, Amaranthus, Cassia, Chlorophytum, Commelina, Cyperus, Euphorbia, Indigofera, Leucas, Sida, Solanum.*
11. Several One-day botanical excursions to botanically rich locations.
12. Botanical excursion of about one week to any botanically rich location preferable outside the State.

SUGGESTED READINGS:

1. AHMEDULLAH, M., AND M. P. NAYAR. 1987. Endemic Plants of the Indian Region. Vol. I. Botanical Survey of India. Howrah.
2. BHOJWANI, S. S. AND BHATNAGAR, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Dehli.
3. BILGRAMI, K. S. AND J. V. DOGRA. 1990. Phyto-Chemistry and Plant Taxonomy. New Delhi, CBS Publishers
4. CRONQUIST, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U. S. A.
5. DANIEL, M. 2009. Taxonomy: Evolution at work. Narosa Publishing House Pvt. Ltd. New Delhi.
6. DAVIS, P. H., AND V. H. HEYWOOD. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
7. DOBSON, A. P. 1996. Conservation and Biodiversity. Scientific American Library. New York, U. S. A.
8. ERDTMAN, G. 1986. Pollen Morphology and Plant Taxonomy: Angiosperms An Introduction to Palynology. Netherland, E. J. Brill, Leiden.
9. FORMAN, L. AND D. BRIDSON. 1989. The Herbarium Handbook. Royal Botanic Gardens, Kew, U. K.
10. GRAHAM, L. E. 1993. Origin of Land Plants. John Wiley & Sons. Inc. New York.
11. GREUTER, W, (Ed.) 2007. International Code of Botanical Nomenclature. (VIENNA CODE) KoeltzVesentific Books. Germany.
12. GROOMBRIDGE, B, (Ed.) 1992. Global Biodiversity: Status of the Earth's Living Resources. Chapman and Hall. London.
13. HENRY, A. N., M. CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
14. HEYWOOD, V. H. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U. K.
15. HUTCHINSON, J. 1973. The Families of Flowering Plants. 3rd Edition. Oxford University Press. Oxford.
16. JAIN, S. K. and R. R. RAO. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.

17. JOHRI, B. M. 1994. Botany in India: History and Progress. Vol-I. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
18. JONES, S. B., AND A. E. LUCHSINGER. 1987. Plant Systematics. 2nd Edition. McGraw-Hill Book Company. New York.
19. JUDD, W. S, C. S. CAMPBELL, E. A, KELLOG, P. F. STEVENS AND N. J. DONOGHUE. 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
20. LAWRENCE, G. H. M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
21. MABBERLEY, D. J. 2005. The Plant-Book, A portable dictionary of the vascular plants. Cambridge University Press, United Kingdom
22. MANILAL, K. S. AND M. S. MUKTESH KUMAR [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
23. MINELLI, A. 1993. Biological Systematics: The State of the Art. London, Chapman & Hall.
24. MONDAL, A. K. 2005. Advanced Plant Taxonomy. New Central Book. Agency Pvt. Ltd. Kolkata.
25. MOORE, R., W. D. CLARK, K. R. STERN AND D. VODOPICH. 1995. Botany: Plant Diversity. Wm. C. Brown Publishers. London.
26. NAIK, V. N. 2000. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Limited, New Delhi.
27. Nair, P. K. K. 1966. Pollen morphology of Angiosperms. Periodical Expert Book Agency, New Delhi.
28. NAYAR, M. P., 1996. "Hot Spots" of Endemic plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Thiruvananthapuram, India.
29. NAYAR, M. P., AND R. K. SASTRY. 1987-1990. Red Data Book on Indian Plants. Vols. I - III. Botanical Survey of India. Howrah.
30. QUICKE, D. L. J. 1993. Principles and Techniques of Contemporary Taxonomy. Chapman and Hall. London.
31. RADFORD, A. E., W. C. DICKISON, J. R. MASSEY, AND C. R. BELL. 1974. Vascular Plant Systematics. Harper & Row. New York.
32. RAVEN, P. H., R. F. EVERT, AND S. E. EICHHON. 1992. Biology of Plants. 5th Edition. Worth Publishers. New York.
33. SANTAPAU, H. AND H. A. HENRY. 1994. A dictionary of the flowering plants in India, CSRI, New Delhi.

34. SHARMA A. AND A. SHARMA. 1980. Chromosome Technique: Theory and Practices (3rd ed.) Butterworths, London.

35. SHIVANNA, K. R. AND N. S. RANGASWAMY. 1992. Pollen Biology- A Laboratory Manual. Springer-Verlag

36. SIMPSON, M. G. 2006. Plant Systematics. Elsevier Academic Press, California, USA.

37. SINGH, G. 2005. Plant Systematics – Theory and Practice. Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.

38. SIVARAJAN, V. V. 1989. Introduction to Principles of Plant Taxonomy. Oxford and IBH Publishing Co. New Delhi.

39. SOLTIS, D. E., P. S. SOLTIS, P. K. ENDRESS AND M. W. CHASE. 2005. Phylogeny and Evolution of Angiosperms. Sinauer Associates, Inc, Massachusetts, USA.

40. STACE, C. A. 1989. Plant Taxonomy and Biosystematics. Edward Arnold, London.

41. STUESSY, T. F. 2002. Plant Taxonomy. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

42. SUBRAMANIAM, N. S. 1995. Modern Plant Taxonomy. Vikas Publishing House. New Delhi.

43. TAKHTAJAN, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendra pal Singh, Dehra Dun, India.

44. TAYLOR, D. V. AND L. J. HICKEY. 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.

45. WILEY, E. O. 1981. Phylogenetics: The Theory and Practice of Phylogenetic Systematics. New York, John Wiley & Sons.

Practical Based on BOT 521 & BOT 522 (Elective-D)

1. Estimation of B - carotene with column chromatography.
2. Estimation of reducing sugars by Folin – Wu tube.
3. Estimation of cellulose by cramption and Maynord Method.
4. Estimation of free fatty acids.
5. Estimation of nitrates.
6. Thin layer chromatographic technique.
7. Techniques of flame photometry: estimation of sodium and potassium.
8. Estimation of gross energy by chromic acid oxidation method.
9. Estimation of N by micro – Kjeldhal's method.
10. Estimation of crude protein, crude fat and crude fiber.
11. Estimation of ash acid soluble / insoluble ash, Nitrogen free extracts and total carbohydrates.
12. Estimation of cell wall constituents, ADF, NDF, cellulose, hemicellulose, lignin etc.
13 Estimation of calcium by titration method.
14. Estimation of phosphorus by SubbaRao and Fiske Method,
15. Growth analysis: AGR, RGR, NAR, LAR, LAI, CGR and LAD.
16. The process of GCF and extractability of dry matter and Nitrogen.
17. Preparation of LPC, by heat coagulation, acid coagulation and fermentation.
18. Preparation of cytoplasmic and chloroplastic LPC by differential heat coagulation.
19. Preparation of TCM using DPJ and Inoculation of explant.

Suggested Readings

1) Hess, D. Plant Physiology, Narosa Publishing House, New Delhi.

2) Mukharji, S. and Ghosh, A. K. Plant Physiology. New Central Book Agencies, Kolkatta.

3) Noggle, G. R. and Fritz, G. S. Introductory plant physiology, Prentice Hall, U. S. A.

4) Vaidya, V. G., Sahasrabuddhe, K. R. and Khupse, V. S. Crop production and field experimentation, Continental Prakashan, Pune - 30.

5) ICAR Handbook of Agriculture, ICAR, New Delhi.

6) Mungikar, A. M. Bibliography of leaf protein in Marathwada University.

7) Pine, N. W. (1971) Leaf protein, its preparation, quality and use, Blackwell Scientific Publ. U. K.

8) Telek, H. and Graham, LT. (1983) Leaf protein concentrates, AVI, Publishing Co., USA.

Service Course- I

(Basic Plant Tissue Culture)

Unit-I (Introduction to Plant Tissue culture): Introduction to Plant Tissue culture, Terms and definitions, Historical background, Laboratory organization, Tools and techniques, methods of sterilization. Laboratory contaminants- it's control and measures.

Unit-II (Media Preparation and dynamics of Growth): Introduction to tissue culture: Media composition, Preparation, Phytohormonesand their usage, selection of media for specified applications, initiation of tissue culture, cellular totipotency, media for initiation of callus, dynamics of callus growth, organogenesis and factors controlling it, genome instability in relation to morphogenesis, somaclonal variation and its applications.

Unit-III (Culture techniques): Cell and organ culture: Plant organ culture; shoot tip, Micropropagation, shoot apical meristem, root, leaf, flower and ovary culture, embryo rescue, somatic embryogenesis, factors influencing embryogenesis, synthetic seeds, suspension culture in stationary and stirred tank reactors,

Unit-IV (Advance Culture techniques): Isolation of single cells and their culture, measurement of growth, protoplast isolation, culture, regeneration and fusion of protoplasts, generation of cybrid and hybrids, cryopreservation of plant cells. Role of Ovary and ovule in *In-vitro* Fertilization in production of agricultural and horticultural crops. Hardening techniques

Unit-V (Recombinant Techniques in Tissue Culture): Recombinant DNA technology: Gene cloning, principles and techniques. Techniques for gene transfer. Markergenes.Applications of tissue culture: Applications in agriculture and industry.

SUGGESTED READINGS

1. Kalyankumar De. Introduction to Plant Tissue culture,
2. Bhojwani, Plant Tissue Culture.
3. Dubey. R. C. a Textbook of Microbiology
4. Montell. S. H. Mathews, J. A., Meker, R. A. Principles of Plant Biotechnology.
5. Glover, D. M. and Hanes, B. D. (eds.) 1995. DNA cloning 1: A practical approach, core techniques, 2nd edition, PAS, IRL press at Oxford University Press.
6. Purohit Plant Tissue Culture
7. Plant cell culture protocols. Humana Press, Inc. New Jersey, USA.
8. Shaw, C. H. (ed.) 1998, Plant Molecular Biology. A practical approach IRI Press, Oxford.
9., R. H. 2000. Plant Tissue culture: Techniques and Experiments. Academic Press, New York.
10. Rajdan : An introduction to plant tissue culture.
11. SandhyaMitra: Genetic engineering.