

SHIVAJI UNIVERSITY, KOLHAPUR.



**Accredited By NAAC with 'A' Grade
Revised Syllabus For**

M. Phil./ Ph. D. Course Work

Botany

**Syllabus to be implemented from
June, 2020 onwards.**

M.Phil/ Pre Ph. D Botany
Paper I : Research Methodology in Botany

Unit I

- Experimental design- Basic principles of experiment:
Experimental unit, sampling unit, Experimental error, replication, Generalization and randomization, control (3)
- Fundamentals of research: Characteristics of research, classification of research (pure research, applied research, descriptive, experimental, historical etc.) (2)
- Research process: Steps and elements, selection, analysis and statement of the problem. Literature collection and citation, bibliography. Writing skills- Preparation of research report, presentations, writing grant proposals.(10)

Unit II

- Data analysis- variables, numerical, categorical.(3)
- Central measures (mean, median, mode). (2) Dispersion measures (range, standard deviation), probability co- (10) relation and regression, Binomial position and normal distribution, parametric and non parametric tests t-test, f-test, chi-square test, ANOVA.(10)

Unit III

- Microscopic Techniques: Light microscope: Resolving power and magnification, Phase Microscope, Fluorescence Microscope, Confocal Microscope, Micrometry. (5)
Electron Microscope: Transmission and scanning techniques for E.M. Spectrophotometer: Electromagnetic spectrum, construction of calorimeter and spectrophotometer, Applications. Analytical techniques- GC-MS, HPLC, FTIR, Maldi, Raman, etc.(10)

Unit IV

- Algal cell culture- Algal culture, Seaweed mariculture. (3)
- Fungal culture- Fungal culture media. (2)
- Protoplast and apori culture Plant cell Culture- Cellular totipotency (4)
- Cytodifferentiation Somatic embryogenesis
- Preservation techniques- Histochemical and cytochemical preservation (2)
- Herbarium
- Molecular biological Techniques- Gene amplification and PCR (4)
- Molecular Probes, DNA fingerprinting

Reference Books:

- P.N..Arora and P.K. Malhan (1998). Biostatistics. Himalaya Publishing Bombay.
- P.S.G. Kumar (2004). Research methods and statistical techniques B.R. publishing Academy, Udaypur, 192.
- G.B.N.Chainy, G.Mishra and P.K.Mohanty(2004) Basic Biostatistics. Kalyani publisher.
- N.Gurumani (2006). Research Methodology for Biological Sciences. MJP publishing, Chennai.
- C.R.Kothari(2004). Research Methodology- Methods and Techniques, New Age Publ. Wiley Eastern, 1985.
- Dawson, Catherina(2002). Practical Res. Methods. New Delhi. UBS Publ.
- Kumar Ranjit(2005). Res. Methodology. A step by step Guide for Beginners. Singapore, Pearson Education.

M.Phil/ Pre Ph. D Botany
Paper II: Recent Trends in Botany

Unit I:

Viruses, Bacteria, Algae and Fungi

Viruses, their structure, classification and viral plant diseases. Bacteria, Structure, recent classification and bacterial plant diseases. Algae-phylogeny and recent classification, Phycocolloids. Fungi-recent classification and phylogeny, fungal biotechnology.(15)

Unit II:

Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany

Evolutionary trends in gametophytes and sporophytes in Bryophytes. Evolutionary trends in Pteridophytes with respect to stele, sori, sporangia, gametophyte and recent trends in classification of pteridophytes. Gymnosperms and their distribution, evolutionary trends in sporophylls and gametophytes. Diagnostic features of major fossil group *viz.* Psilophytales, Sphenophyllales, Cycadofilicales, Bennettitales, Cordaitales.(15)

Unit III:

Angiosperms, Biodiversity, Anatomy, Embryology, Palynology and Ethnobotany

Recent trends in classification of Angiosperms, taxonomy and conservation biology. Role of anatomy, embryology, phycology and ecology in taxonomy. Scope and interdisciplinary approach in Ethnobotany. Role of tissue culture in Biodiversity and in conservation.(15)

Unit IV:

Ecology, Physiology and Cytogenetics

Systems ecology, Environmental software, Remote sensing, Environmental impact assessment, climate change and risk analysis. C₃, C₄ and CAM pathway of Carbon fixation. Genetic Engineering in crop plants, Gene transfer techniques, characterization of specific genes, Gene isolation methods, direct and indirect gene transfer methods. Production of transgenic for biotic and abiotic stresses quality improvement. (15)

References:

- Smith A. J. E. (1982). Bryophyte ecology, Chapman and Hall, Landon New-York.
Udar Ram (1976). Bryophytes in India. ed. by P. Primlane, New Delhi, Chronic Botanica.
Vanderpoorten, A. (2009). Introduction to Bryophytes. Cambridge University Press, Edt. 1
Vashishta, B. R. (1986). Bryophyta. S. Chand and Co. Ltd. , New – Delhi.
Wood, A. J., M. J. Oliver and D. J. Cove (2004). New forniters in Bryology – Physiology Molecular Biology fna Functional Genomics. Springer.
Birehost, D. W. (1971). Morphology of vascular plants. Macmillon New York.
Bower, F. O. (1923 - 1928). The fern Vol. I – IV. Cambridge University Press Cambridge UK.
Rashid, A. (1991). An introduction to Pteridophytes. Hutchinson vaiv London.
Trivedi, P. C. (2002). Advances in Pteridology, Pointer publication. Jaipur,
Vashishta, P. C. (2001). Pteridophyta. S. Chand and Co. Ltd. New Delhi.
Beddome, R. H. (1863). The ferns of South India. Grantz Bros. Madras; Reprinted 1970.

Misra, R. and R.R.Das(1971). Proceedings of the school on plant ecology.

Osborne, P.L.(2000). Tropical ecosystems and ecological concepts.

Cambridge University Press.

Robert, J. Reimold and Willim, H.Queen(1974). Ecology of Halophytes.

Synge, H. (1981). The Biological aspects of rare plant conservations.

John Wiley and Sons.

Willis, A.D.(1973) Introduction to plant Ecology.

YoavWaisel (1972).Biology of halophytes

- L. Taiz and E. Zeiger (2002) Plant Physiology (Second Edition) Simauer Associates Inc Publishers Sunderlands,Massachusetts
- H.W. Heldt (1997) Plant Biochemistry and Molecular Biology Oxford University Press
- W.G. Hopkins (1985) Introduction to Plant Physiology John Wiley and Sons, Inc. New York
- Methods in Enzymology Colowick and Caplan Academic Press, New York
- Coombs, Hall, Long and Scurlik (1985) Techniques in Bioproductivity and Photosynthesis, Pergmon Press, Oxford
- Hall, Scurlik, Bolhar, NordenKamf, Leagood and Long (1993) Photosynthesis and production in a Changing Environment. A Field and Laboratory Manual, Chapman and Hall Publication
- Buchanan, B.B., Gruissem, W. and Jones, R.L.(2000) Biochemistry and Molecular Biology of Plants. I.K. International Pvt.Ltd., New Delhi, Mumbai, Bangalore Smith,
- J.E and D.R.Berry. 1978. The filamentous fungi. Vol-I Industrial mycology. Voll-II Development Mycology, Edward Arnold Publ.London
- Taiz, 1, and E.Zeiger. 1998. Plant physiology, sinquer Associnc. publ. New York.
- Trehan. K.1994. Biotechnology, Wiely Eastern Lte, New Delhi.
- Vaidya, J.G 1995 Biology of the fungi, SatyajeetPrakashan,Pune.
- Vyas, S.C.1992. Hand Book of Systemic fungicides, Vol-I,II,III,Tata Mc-Graw Hill New Delhi
- Ray Samit and A.K.Ray (ed.) 2006. Biodiversity and Biotechnology. New Central Book Agenc(p.) Ltd. Kolkata; India.
- Singh Gurucharan 2010. Plant systematic: An Integrated approach. Science publisher. USA.
- Judd, W.S., Campbell, C.S., Kollogg, E.A., Stevens, P.F. and Donoghue M.J.2008. Plant systematic: phylogenetic approach. Sircuier Associates, Inc. Futuyma D.J.2009. Evolution. Sinauer Associates, INC. Publishers, Sunderland. USA.
- Groom, M.J., Meffe, G.K. and Carroll, C.R.2006. Principles of conservation biology.
- Sircuier Associates, Inc.Etelka leadlay and Stephen jury (ed.) 2006 Taxonomy and plant conservation

M. Phil. and Ph.D. Paper III
(Special)
Recent Advances in Plant Physiology

Unit-I

1. Lipids- structural and storage lipids and their functions. (5)
2. Amino acid biosynthesis and assimilation in plants. (5)

Unit-II

3. Secondary metabolites- Role of natural products in plant defense, pharmaceuticals and cosmetics.(5)
4. Development of transgenic plants for abiotic stress tolerance Phytoremediation.
Stress Proteins in plants- HSP, osmotin, PR, BSIPS, salt-, cold- and UV light-induced proteins. (5)

Unit- III

5. Organic and biodynamic farming- concept, principles, Best types of composite herbal preparations, Botanical biopesticides and their applications. (5)
6. Free radicals and site, source and mechanism of free radical scavenging. (5)

Unit- IV

7. Hormonal regulation of plant growth and development, signal Transduction (4)
8. Role of PGR in agriculture and horticulture (3)
9. Status of Plant Physiology Research in India (3)

References:

- L. Taiz and E. Zeiger (2002) Plant Physiology (Second Edition) Simauer Associates Inc Publishers Sunderland, Massachusetts
- H.W. Heldt (1997) Plant Biochemistry and Molecular Biology Oxford University Press
- W.G. Hopkins (1985) Introduction to Plant Physiology John Wiley and Sons, Inc. New York
- Methods in Enzymology Colowick and Caplan Academic Press, New York
- Coombs, Hall, Long and Scurlik (1985) Techniques in Bioproductivity and Photosynthesis, Pergamon Press, Oxford
- Hall, Scurlik, Bolhar, Nordenkamf, Leagood and Long (1993) Photosynthesis and production in a Changing Environment. A Field and Laboratory Manual, Chapman and Hall Publication
- Buchanan, B.B., Gruissem, W. and Jones, R.L.(2000) Biochemistry and Molecular Biology of Plants. I.K. International Pvt.Ltd., New Delhi, Mumbai, Bangalore

Journals

Annual Review of Plant Physiology and Molecular Biology Trends of Plant Sciences
Plant Physiology Physiologia Plantarum
Journal of Experimental Botany Indian Journal of Plant Physiology

Paper III
Recent Advances in Mycology and Plant Pathology

Unit-I

- 1 Current scenario of Mycology and Plant Pathology in India 02
2. Role of Fungi in Biotechnology: Selection, Production formulation and Commercial use of fungi in biocontrol of plant diseases, insect and weeds. Ganomedicines. (8)

Unit-II

3. Molecular techniques for Identification and classification of fungi 05
4. Seed pathology: Major seed borne plant pathogens of fungal, bacterial and viral origin. Techniques involved in identification of seed borne pathogens.(5)

Unit-III

5. Recent concept of plant defense: Mechanism of sensing pathogenicity, Systemic Acquired Resistance (SAR), Biochemical defense, Regulation of lignifications in defense. 10

Unit-IV

6. Fungal protoplast: Isolation, mycolytic enzymes, hyphal organization And protoplast formation, PEG induced and electro fusion of protoplast, Application and feature prospectofprotoplast.. 05
- 7 Chemical management of plant pathogens. 05

● **Reference:**

- Dennis, E.S.et al, 1992 plant Gene Research: Basic knowledgeand Application. Springer-verlage Wien Publ. NewYork.
- Gengopadhyay , S 1984 Clinical plant pathology, Kalyani Publ.New Delhi
- Nane Y.1 and Thapliyal 1979, fungicides in plant diseasecontrol. Oxford IBH, Publ. NewDelhi.
- Smith, J.E and D.R.Berry. 1978. The filamentous fungi. Vol-I Industrial mycology. Voll-II Development Mycologym, Edward Arnold Publ.London
- Taiz, 1, and E.Zeiger. 1998. Plant physiology, sinquerAssocinc. publ. NewYork.
- Trehan. K.1994. Biotechnology, Wiely Eastern Lte, NewDelhi.
- Vaidya, J.G 1995 Biology of the fungi, SatyajeetPrakashan,Pune.
- Vyas, S.C.1992. Hand Book of Systemic fungicides, Vol-I,II,III,Tata
- Mc-Graw Hill NewDelhi.
- Whipps, J.M. and R.D.Lumsden. 1989. Biotachnology of Fungi for Improving plant Groth. Cambridge Univ. Press, publ. NewYork.

Journals

Indian Phytopathology
Annual Review of Plant pathology
Index of Fungi
Phytopathology
Kavaka

Paper III
A Recent Advances in plant Protection

Unit-I

1. A general over-view of organization of plant Protection and Research in India 04
2. General instruction for use and safe handling of pesticide. 06

Unit-II

1. Pest control strategies in India 04
2. Major diseases of important fruit crops
(Citrus, Pomes, Mango, Banana, Grape, Guava, Strawberry, Ber Coconut) of Maharashtra and their control 06

Unit-III

3. Problems of pesticide residue Techniques used in analysis of pesticidal residue 03
4. Chemical manipulation of plant for disease resistance 02
5. Protection of grains, fruits, vegetable flowers during transport and storage 05

Unit-IV

6. The development of herbicide resistant crops 05
7. Chemical management of insect pests 05

● **Reference**

- Annual Review of plant Physiology and Molecular Biology, 40. 1989
- Chattopadhyay, S.B. 1980, Principles and procedures of plant protection Oxford IBH Publ, New Delhi
- Plant Protection Recommendations, Gov. of Maharashtra, 1985. Dept. of Agri. College, Pune
- Preservation of Post harvest food losses. FAO, Training manual. 1989.
- Singh, R.S. 2000. Diseases of fruit crops, Oxford and IBH Publ, New Delhi.
- Zha, L.K. 1985. Agricultural Entomology, New central Book Agency, Publ, Calcutta.

PAPER-III
TAXONOMY, BIODIVERSITY AND CONSERVATION

UNIT I

Taxonomy and Biodiversity: The principles and practices of Taxonomy. The role of Taxonomy. Global biodiversity, measures of biodiversity, diversity indices, biodiversity values, use and importance of biodiversity, threatened biodiversity, major causes of biodiversity loss. Biodiversity of India. RET species. The role of Taxonomist in conservation. (10)

UNIT II

Variation, Biosystematics, population genetics and evolution: Key concepts in plant evolution. Developmental, experimental and genetic variations, breeding systems, apomixes, population genetics, evolution (10)

UNIT III

Plant classifications: Phenetic methods, molecular Systematics, cladistic methods, Phylogenetics analysis, APG classification. Diagnostic features, systematic position and affinities of major groups of flowering plants recognized in APG classification: Basal angiosperms, Magnoliids, Monocots, Commelinids, Eudicots, Core Eudicots-II. (10)

UNIT IV

Taxonomy and conservation: Needs, politics, Economics, issues, plant diversity. Biotechnology and biodiversity conservation, In-situ and ex-situ conservation. Climate change and Biodiversity. Biodiversity and Forest Acts. Environment Impact Assessment. Role of Botanical Gardens in plant conservation. Concept of Lead Botanical Gardens and Biodiversity Parks. National Programmes on plant conservation. (10)

Reference books:

- Ray Samit and A.K.Ray (ed.) 2006. Biodiversity and Biotechnology. New Central Book Agenc(p.) Ltd. Kolkata; India.
- Singh Gurucharan 2010. Plant systematic: An Integrated approach. Science publisher. USA.
- Judd, W.S., Campbell, C.S., Kollogg, E.A., Stevens, P.F. and Donoghue M.J.2008. Plant systematic: phylogenetic approach. Sircuier Associates, Inc. Futuyma D.J.2009. Evolution. Sinauer Associates, INC. Publishers, Sunderland. USA.
- Groom, M.J., Meffe, G.K. and Carroll, C.R.2006. Principles of conservation biology. Sircuier Associates, Inc. Etelka leadlay and Stephen jury (ed.) 2006 Taxonomy and plant conservation. Cambridge University press. UK.
- David Briggs 2009. Plant microevolution and conservation in human influenced ecosystems. Cambridge University press. UK.

Paper III
Recent Advance in Plant Ecology

Unit I:

- A) Phytogeography of Indian Subcontinent.
- B) Ecology in a global Economy.
- C) Image of Ecology Economics.
- D) Globalization as a global opening concept of sustainable development. (10)

Unit II:

- A) Plant habitat relationship: Allelopathy
- B) Mechanism of self- regulation in ecological systems.(10)

Unit III

- A) Understanding rarity and monitoring rare plants population. Use of IUCN guidelines.
- B) Population Size: Conservation Dilemma.
- C) Concept of minimum viable populationsize.
- D) Concept of maximum tolerance populationsize. (10)

Unit IV:

- A) Restoration of degraded lands: Habitat restoration for afforestation with any suitable example.
- B) Ecotoxicology with respect to contamination of food chains. Ecofriendly approach, Bioremediation, Greenproducts. (10)

REFERENCES

- Braun Blanquet J. (1972).** Plant Sociology
- Davy, A.S. Hutchings, M.S. and Watkinson, A.R. (1988).** Plant population Ecology, 28th Symposium of the British Ecological Society.
- Grieg Smith p. (1983).** Quantitative Plant Ecology.
- Hanson, C.H. and Churchill, E.D.(1965).** The Plants community.
- Haywood, V.H.(1973).** Taxonomy and Ecology.
- Krebs, C.J.(1994).** Ecology (IV ed.) the experimental analysis of Distribution and abundance, Hamper Collins.
- Misra, R. ans R.R.Das(1971).** Proceedings of the school on plant ecology.
- Osborne, P.L.(2000).** Tropical ecosystems and ecological concepts. Cambridge University Press.
- Robert, J. Reimold and Willim, H.Queen(1974).** Ecology of Halophytes.
- Synge, H. (1981).** The Biological aspects of rare plant conservations. John Wiley and Sons.
- Willis, A.D.(1973)** Introduction to plant Ecology.
- YoavWaisel (1972).** Biology of halophytes.
- Brij Gopal,P.S.Patak,K.G.Saxena (1998).** Ecology Today- an anthology of Contemporary Ecological research. International Scientific publication

Journals:

Nature and Biosphere.

Nature.

Environment and Pollution technology, Ecology,

Environment and conservation, Indian Journal of Environment and Ecoplaning, Journal of Tropical Ecology

**PAPER III:
RECENT ADVANCES IN MARINE BOTANY**

UNIT I

Coastal Geomorphology: Coastal dunes, deltas, mangrove coast and beaches, coastal reefs, classification of Indian shorelines. (2)

Classification of marine plants: monera, protista and plantae. (1)

Macroalgal communities: Psammophytes, Epiphytes, Drift seaweed sand blooms. Mangrove associates. (3)

Coastal soils: Physical and chemical properties of Indian coastal soils, Characteristics of mangrove soils-texture, pH, salinity, nutrients, organic matter etc. (4)

UNIT II

Light and marine plants: phycobilisomes in red and blue-green algae, pigments and light harvesting, carbon fixation response to light quality, effect of UV Band ozone. (4)

Temperature and marine plants: Effect on metabolism, heat and cold tolerance, Ice and marine plants, Global warming. (3)

Osmoacclimation, Salinity and marine plants: Mangroves and global climate change. (3)

UNIT III

Seaweed mariculture: Cultivation of *Porphyra*, *Laminaria*, *Undaria*, *Eucheuma* and others, domestication of seaweeds, seaweed biotechnology- current status and future prospects. (7)

Seaweed productivity, carbon translocation and C₃-C₄ characteristics of Seaweeds. (3)

UNIT IV

Coastal regulation zone notification: CRZ -I, CRZ- II, CRZ- III, CRZ-IV, Coastal bioshield concept and importance. (5)

Present status of research in marine plants: Mangroves, Marine algae, Sea grasses, Salt marsh and Sand dune plants (5)

Reference Books:

C.S. Lobban and P.J. Harrison (2004) Seaweed Ecology and Physiology.

C.J. Dawes (1998) Marine Botany.

P.J. Hogaarth (2006) The Biology of Mangroves

P.B. Tomlinson (1986) The Botany of Mangroves

K. Kathiresan & S.Z. Qasim (2005) Biodiversity of Mangrove Ecosystem

A.K. Bandopadhyay (1997) Coastal Soils & their Management

Creeks, Estuaries & Mangroves. Pollution and Conservation (2002) Proc. Natl. Seminar Thane.

Paper-III
Recent Trends in Biotechnology

UNIT-I

Techniques in Biotechnology

- 1) Application of Tissue culture and achievements in plant biotechnology 03
- 2) Techniques in biotechnology:
Molecular diagnostics- Immunological, DNA diagnostic systems, molecular diagnostics of genetic diseases, Array based markers (SFPs,DArT). 05
Transgenic crops: Crop productivity and nutritional quality.02

UNIT-II

Molecular Biotechnology

- 1) Construction of synthetic vectors and their uses in r-DNA technology. 05
- 2) An over view of gene silencing and its applications. 03
- 3) DNA bar-coding in plants. 02

UNIT-II

Biotechnology and Biosafety

- 1) Objectives, risk assessment, regulation, Biosafety during industrial .06
- 2) Production, Biosafety guidelines in India, Guidelines and regulation.
- 3) Biotechnology for environment: Bioenergy, Biofuel, Bioremediation and 04
and Climate change

UNIT-IV

Genomics, Proteomics and Bioinformatics

- 1) Sequencing of whole genome, functional and comparative genomics 05
(Rice, Arabidopsis, Soyabean)
- 2) Proteomics and Proteome analysis 02
- 3) Bioinformatics and data mining (In silico Biology) 03

REFEREMCES

- 1) **Agarwal, S.K.**(2007) Bioinformatics. APH Publishing Corporation, New Delhi.240.p
- 2) **Glick, B.R. and Pasternak, J.J.** (1994) Molecular Biotechnology: Principles and Application of r- RNA Press, Washington.
- 3) **Gupta, P.K.** (2006) Cell and Molecular Biology, Third edition. Rastogi Publications, Meerut.
- 4) **Kumar, S. and Flading M.** (2005) Molecular Genetics and Breeding of Forest Trees. International Book Distributers, Lucknow.436p.
- 5) **Mandal, A.K. and Gibson, G.L.** (2008) Forest Genetics and Tree Breeding. CBS Publishers and Distributers, New Delhi.268p.
- 6) **Russell, P.** (2010) Genetics- A Molecular Approach, Third edition. Pearson Benjamin Cummings, San Francisco.828p.
- 7) **Sharma, Munjal and Shankar** (2008) A Textbook of Bioinformatics. Rastogi Publications, Meerut.
- 8) **Singh, B.D.**(2009) Biotechnology: Expanding Horizons,.Kalyani Publishers.919p.
- 9) **Thangadurai, D., Song, W.T. and Song, Q.** (2007) Plant Stress and Biotechnology.257p.

Paper-III
Cytogenetics and Plant breeding

Unit-I

Molecular Cytogenetics

(10)

- a) Nuclear DNA content and its organization.
- b) Genetics, Cytogenetics and Physical maps using molecular markers.
- c) Multigene families in Eukaryotes.

Unit-II

Plant Breeding

(10)

- a) Marker Assisted Selection (MAS) : Selection of markers for foreground and background selection, epigenetics and epigenomics for crop improvement, different breeding scheme involving MAS, gene pyramiding, economics of MAS and its achievements.
- b) Release of new varieties; quality seed.
- c) Intellectual property rights in relations of plant breeding.

Unit-III

Molecular Genetics

(10)

- a) Organization of genetic material: Split genes, overlapping gene, pseudo genes and cryptic gene.
- b) Regulation of gene expression: Operon circuits in bacteria and other prokaryotes, circuits for lytic and lysogeny in bacteriophages, variety of mechanisms in eukaryotes.
- c) Functional Genomics: Genome annotations, mutagenesis, gene silencing and transcriptomics and proteomics.

Unit-IV

Genetic engineering and Biotechnology

(10)

- a) Transgenic crops for crop productivity and nutritional quality, vegetables and horticulture crops.
- b) Molecular farming and Pharming: Transgenic plants for specially chemicals, edible vaccines, antibodies and biopharmaceuticals.
- c) Field testing and commercialization.

Reference Books:

Singh, B. D. 2000. Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana.

Sharma, J. R. 1994. Principles and practice of plant breeding. Tata Mc Grow Hill Publ. Co. Ltd., New Delhi.

Siddiqui B. A. and Khna S. 1999. Breeding in crop plants. Mutation and In vitro mutation breeding . Kalyani Publishers New Delhi

IAEA 1995. Induced mutations and Molecular techniques for crop improvement. Proc

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Gustafson J. P. 2000 Genomes. Kluwer Academic Plenum Publishers New York USA.

Brown T. A. 1999 Genomes. John Wiley and Sons Pvt. Ltd. Singapore.

Liu Ben Hui 1998 Statistical Genomics :Linkage Mapping and QTL Analysis. CRC Press LLC Florida USA.

Wennacker Ernst L. 1987 From Genes to Clones; Introduction to Gene Technology VCH publishers Weinheim (Federal Republic of Germany)

Mount D. W. 2001 Bioinformatics Sequence and Genome Analysis. Cold Spring Harbour Laboratory. New York.

Thimmaiah S. R. 1999, Standard methods of biochemical analysis. Kalyani Publishers Ludhiana.

Mitra Sandhya 1996, Genetic Engineering Macmillan India Ltd.

Lal R. and Lal S. 1993, Genetic engineering of plants for crop improvement. CRC Press.

Winkler, U. Ruger W. and Wackernagel W. 1979. Bacterial phage and molecular genetics. Narosa Publication New Delhi.

Chawala H. S. 2000 Introduction to Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd.

Vidhyashekar P. 1993 Molecular biology and tissue culture fro crop pest and disease management. Daya Publishing House New Delhi.

Kumar U. 2005 Methods in Plant Tissue culture Agrobios Jodhpur India.

Razdan M. K. 2003 Introduction to plant tissue culture. Oxford and IBH publishing Co. Pvt. Ltd.

Gustafson J. P. 1990 Gene manipulation in plant improvement I and II. Plenum Press London.

Old R. W. and Primrose S. B. 1989 Principles of Gene Manipulation. Blackwell Scientific Publ Oxford UK.

Micke A. 1991. Induced Mutation for crop improvement. Gamma Field Symposia No.30 Institute of Radiation Breeding Pullman USA.

Allard R. W. 1960. Principles of Plant Breeding John Wiley and Sons, New York.

Hays H. K., Immer F.R. and Smith D.C. 1955. Methods of Plant Breeding. McGraw Hill Book Company Inc New York.

- Fehr W. R.** 1987. Principles of Cultivar Development (2 Volumes) MacMillan Publishing Co. New York.
- Poehlman J.M.** 1986. Breeding Field Crops AVI Publishing Company Connecticut. NEW YORK
- Sharma J. R.** 1998. Statistical and Biometrical techniques in Plant Breeding New Age International Publishers New Delhi.
- Singh R. K. and Singh B. D.** 1997. Biometrical Methods in Quantitative genetic Analysis. Kalyani Publishers, New Delhi.
- Vijendra Das L. D.** 2000. Problems Facing Plant Breeding CBS Publishers New Delhi
- Rosielle A. A. and Hamblin J.** 1981 Theoretical aspects of selection for yield in stress and non-stress environments Crop Sci, 21: 932-946.
- Levitt J.** 1980. Response of Plants to Environmental Stress: Water, Salt and Other stresses. Academic Press, New York.
- Bulm A.** 1988. Plant Breeding for stress Environments. CRC Press Florida.
- Chopra V. L.** 1989. Plant Breeding .oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Roy Darbeshwar** 2000, Plant breeding analysis and exploitation of variance. Narosa Publishers New Delhi.

PAPER III
Recent Advances in Bryology and Pteridology

- Unit I (10)
- Towards an experimental approach to Bryophyte taxonomy
 - Spore morphology in Bryophytes
 - Regeneration in Bryophytes
- Unit II (10)
- Ultra structural studies in Bryophytes
 - Chemical constituents of Bryophytes
 - Conduction in Bryophytes
 - The mineral economy of Bryophytes
- Unit III (10)
- Recent contribution in Indian Pteridophytes
 - Abnormalities in the life cycle of Pteridophytes
 - Cytology and Evolution of Ferns.
 - Morphogenic aspects of sporophytes
- Unit IV (10)
- Evolution of the stellar system
 - Spore germination and gametophytic initiation
 - Regeneration of gametophyte
 - Bactericidal properties of pteridophytes

Referances

- Cavers, F. (1964). Interrelationships of Bryophytes, London, Dawsons of Pali. Mall
- Chopra, R. N. and P. K. Kumar (1988). Biology of Bryophytes. Wiley Eastern Ltd. New Delhi
- Clarke, G. C. S. and J. G. Duckett (1979). Bryophyte Systematics. London Academic.
- Puri, P (1981). Bryophytes: morphology, growth and differentiation. Atma Ram and Sons Delhi – Lucknow
- Porley, R. and N. Hodgetts (2005). Mosses and Liverworts. Harper Collins, London, U. K.
- Shaw, A. J. and B. Goffinet (2000) Bryophytes Biology, Cambridge University, Press; Reprinted 2002
- Smith A. J. E. (1982). Bryophyte ecology, Chapman and Hall, London New-York.
- Udar Ram (1976). Bryophytes in India. ed. by P. Primlane, New Delhi, Chronic Botanica.
- Vanderpoorten, A. (2009). Introduction to Bryophytes. Cambridge University Press, Ed. 1
- Vashishta, B. R. (1986). Bryophyta. S. Chand and Co. Ltd. , New – Delhi.
- Wood, A. J., M. J. Oliver and D. J. Cove (2004). New frontiers in Bryology – Physiology Molecular Biology and Functional Genomics. Springer.
- Birehost, D. W. (1971). Morphology of vascular plants. Macmillan New York.
- Bower, F. O. (1923 - 1928). The fern Vol. I – IV. Cambridge University Press Cambridge UK.
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- Trivedi, P. C. (2002). Advances in Pteridology, Pointer publication. Jaipur,

Vashishta, P. C. (2001). Pteridophyta. S. Chand and Co. Ltd. New Delhi.
Beddome, R. H. (1863). The ferns of South India. Grantz Bros. Madras; Reprinted 1970.
Beddome, R. H. (1864 – 70). The ferns of British India. Grantz Bros Madras.
Blatter, E. and J. f. D’Almeida (1922). Pteridophyte flora of the Western ghats South India. B. I. Publications, New Delhi.

Journals

- Indian fern Journal
- American fern Journal. (www.bioone.org/loi/amfj).

Phytotaxa. (www.mapress.com/phytotaxa/editor.htm)

Paper III
Recent advances in phycology

Unit I

History of phycology and algal studies in India

Recent trends in algal taxonomy (3)

Basis of classification, modern classification of algae, important classes and their interrelationships, evolution and phylogeny. (7)

Unit II

Algal biodiversity –Distribution in fresh and marine habitat, algal blooms (3)

Culture and cultivation, commercial cultivation (mass cultivation) of economically important algae, methods of preservation. (7)

Unit III

Biochemistry and genetics

Pigments, carbohydrates, lipids, proteins and important bioactive compounds (5)

Chromosome number, use of algal systems in genetical studies, work done in India. (5)

Unit IV

Algae and human welfare

Biotechnological potential of algae- SCP, biofertilizer, bioremediation, biofuels, nutraceuticals, raw material for industries, algal toxin (10)

References :

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Vashishtha B.R. 1995 Algae S.Chand & co.ltd., New Delhi

P.C.Trivedi Algal Biotechnology, Pointer publ.

Mihir kumar Das Algal Biotechnology

Mihir kumar Das Algal culturing techniques.

Bhatnagar & Saxena, Algal biofuels, Stedim press, India, ltd.