Course code: - BOT/MJ/UD/550 - (SAD265502T)

Course Name: Course Name: CYTOLOGY AND GENETICS

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

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.

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) Historical perspective
ii) Spontaneous and induced mutations
iii) Physical and chemical mutagens
iv) Mode of action and molecular basis of gene mutations
v) Transposable elements and mutation induced by transposons
vi) Applications of various mutation techniques
vii) Role of mutations in crop improvement programme

Unit IV: DNA damage and repair mechanism

i) Fine structure of gene, cis- trans-test, introns and their significance in RNA splicing

ii) DNA damage and repair mechanism

iii) Initiation of cancer at cellular level. Proto-oncogenes and oncogenes

Unit V: 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) Regulation of gene expression in prokaryotes and eukaryotes.

Suggested Reading:

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 (4ih 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 (2nd Ed),WCB, McGraw Hill, USA.
9. Malacinski, G. M. and Friefelder, D. 1998. Essentials of Molecular Biology (3rd Ed.), John and Bartlet Publishers Inc. London.Russel, P. J. 1998. Genetics (5th Ed) The Benjamin / Cummings Publishing Company, Inc. USA.
10. Powar C. B. (2016) Essentials of Cytology, Himalaya Publishing House, New Delhi
11. Sen Sumitra, Dipak Kumar Kar and B. M. Johri (2005) Cytology and Genetics, Alpha Science Publications
12. Sharma A. K. and Sharma Archana (2016) Chromosome Techniques, Theory and Practice, Butterworth Publication
13. Snustad, D. P. and Simmons, M. J. 2000. Principles of Genetics (2nd Ed.), John Wiley and Sons Inc. USA.

Course Code: - BOT/MJ/UD/551 - (SAD265512T)

Course Name: Plant Development and Reproduction

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

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.

i. Organ determination: Leaf, stem, root etc.

Unit II.

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

ii. Leaf: Growth and differentiation, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.

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

Plant Reproduction

Unit III.

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 IV.

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, megasporogenesis, 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.

iv. Fruit development and seed dispersal mechanisms.

Suggested readings:

Bhojwani and Bhatnagar (2000) The Embryology of Angiosperms, S. Chand Pub. New Delhi

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 D. F. (1978). Applied Plant Anatomy, Longman, United Kindom

Cutter E. G. (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 W. C. (2000).Integrative Plant Anatomy, Harcourt Academic Press, USA.

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

Fahn, A. 1974, Plant Anatomy, Pergmon Press, USA & UK.

Fahn, A. 1977, Plant Anatomy' (3rd edition, 1982).Pergamon Press, Oxford.

Forster, A. S. 1960. 'Practical plant anatomy D.vanNostrandcompany.Inc.

Fosket D. E. 1994, Plant, Growth and Development: A Molecular Approach, Academic Press.

Foskt D. E. 1994 'Plant growth and development' - A molecular approach Academic Press, Santiago.

Fritsch F. E. 1935, 1945, The Structure and Reproduction of Algae Vols.I and II.Cambridge University Press, Cambridge, UK.

Frugis Givoanna, 2020, Plant Development and Organogenesis: From basic principles to advanced research, M D P I

Hopkins W. G., 2006, The Green World: Plant Development, Chelsea House Publication

Howell S. H., 1998, Molecular Genetics of Plant Development, Cambridge University Press.

Howell, S. H., 1998, Molecular genetics of plant development, Cambridge University Press, Cambridge.

Hyndon, R,F. 1990, Plant Development - The Cellular Basis Univ. Hyman, London.

improvement Cambridge University Press. Cambridge.

Leyser O. and Day S. 2003, Mechanism of Plant Development, Blackwell Press

Maheshwari P., 2000, An introduction to the Embryology of Angiosperms,

Mauseth J. D.,1988, Plant Anatomy, The Benjamin/ Cummings Publisher, USA

Metcalf and Chalk, 1950, Anatomy of Dictotyledons vol. I & II, Clarendon Press.

Murphy, T. M. and Thompson, W. F. 1988, Molecular plant development, Prentice Hall, New Jersey.

Nair M. N. B., 1998, Wood Anatomy and Major Uses of Wood, Faculty of Forestry, University of Putra Malaysia, Malaysia. 11

Nels R. Lersten, 2014, Flowering Plant Embryology, Wiley, New Delhi

Pandey A. K., 2010, ntroduction to Embryology of Angiosperms,

Procton, M. and Yeo, P., 1973, 'The pollination of flowers', William Collins Sons, London.

Raghavan V., 1997, Molecular Embryology of Flowering Plants. Cambridge University Press.

Raghavan V. 2000, Developmental Biology of Flowering Plants, Springer, Netherlands

Raghavan, V., 1999, Developmental Biology of flowering plants', Springier Verlag, New York.

Raven, P. H., Evert, R. F. and Eicbhom, S. E. 1992 'Biology of Plants' (5^{th} Edition), New York.

Richards A. J., 1986, Plant Breeding System, George Allen and Unwin.

Roberts, L. W., 1976, Cyto-differentiation in plants, Cambridge University Press, Cambridge.

Shivanna K. R., 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. Sawhney, (Ed) 2005, 'Pollen Biotechnology for crop production and Improvement, Cambridge University Press.

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

Course Code: - BOT/MJ/UD/552 (SAD265522T)

Course Name: Biology and Diversity in Fungi and Microbes

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Fungi:

Unit I. a) Fungi - General characteristics in fungi.(Ultrastructure and Reproduction). General account and outline of Classification (Ainsworth 1973)

b) Economic importance of fungi –

Fungi in Agriculture (Biopesticides and Biofertilizers), Fungi in medicine Fungi in industry, Fungi as source of food (SCP, Mushrooms).

Unit II: Fungi as plant pathogens

- General account of different groups and type study of fungi as pathogen.
  - Mastigomycotina -*Phytophora, Albugo.*
  - Zygomycotina - *Rhizopus, Mucor*.
  - Ascomycotina -*Claviceps, Erysiphae,*
  - Basidiomycotina -*Puccinia, Ustilago,*
  - Deuteromycotina - *Alternaria, Aspergillus, Penicillium, Fusarium, Cercospora, Helminthosporium.*

Bacteria:

Unit- III.

a) General characters, ultrastructure, classification, Koch's postulates,

- Archaebacteria and Eubacteria.
- Economic importance of Bacteria,
- Role of bacteria in nitrogen fixation, Role of agrobacterium in GM crops.
- Bacteria as plant pathogens: Citrus canker, Angular leaf spot of Cotton. Soft rot of fruits.

Unit –IV Phytoplasma :

a) Phytoplasma**:** General Account, ultrastructure and economic importance

b) Phytoplasma as plant pathogens: Grassy shoot of Sugarcane, Little leaf of Brinjal, Sesamum phyllody

Unit- V Virus :

a) General account, ultrastructure, Transmission and multiplication of viruses.

b) Economic importance of viruses.

c) Virus carrying human diseases (HIV, COVID-19, SARI).

d) Viruses as plant pathogens: Tomato / Chilli leaf curl virus, Papaya leaf mosaic Virus, Yellow vein mosaic virus of Bhindi.

Suggested Reading:

1. U. Sinha and Sheela Shrivastava (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.10.
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. Luria S. 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.Mc Carth- 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. Rangaswami G. & A. Mahadevan (2001) - Diseases of Crop Plants in India., Prentice Hall of India, New Delhi.

Course Code: - BOT/MJ/UD/553 (SAD265502P)

(Practical based on BOT/MJ/550)

Course Name: Practical - Cytology and Genetics

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

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 behavior of monosomy in plants & its effect.
8. Meiotic behavior 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* larvae.
11. Study of chromosome pairing and disjunction in translocation heterozygote.
12. Utilization of banding technique for identification of chromosomes in karyotype.

Course Code: - BOT/MJ/UD/554 (SAD265512P)

(Practicals Based on BOT/MJ/OC/551)

Course Name: Practical - Plant Development and Reproduction

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

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.

Course Code: - BOT/ MJ/UD/555 (SAD265522P)

(Practical based on BOT/MJ/UD/552)

Course Name: Practical - Biology and Diversity in Fungi and Microbes.

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

01. Principal and working of instruments, Sterilization Methods.
02. Preparation of Media, stains and Isolation of Bacteria and Fungi from soil and infected plant tissues.
03. Gram staining of bacteria.
04. Morphology and Taxonomy of following fungi - *Albugo, Phytophthora, Mucor, Rhizopus, Plasmopara, Sclerospora, Taphrina, Claviceps, Chaetomium, Puccinia, Ustilago, Agaricus, Polyporus, Ganoderma, Cyathus, Lycoperdon, Geaster, Alternaria, Aspergillus, Penicillium, Helminthosporium, Cercospora, Curvularia, Fusarium, Rhizoctonia, Colletotrichum.*
05. Growth of Fungi on liquid and solid media — *Fusarium* and *Alternaria.*
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, Sesamum phyllody, Grassy shoot of sugarcane.
08. Study of viral plant diseases - Papaya mosaic virus (PMV), Tomato leaf curl virus (TLCV), Yellow vein mosaic virus of Bhindi (YVMV), Tobbaco Mosaic Virus (TMV).
09. Collection and submission of fungal, bacterial, phytoplasma and viraldiseases of plants.

Course Code: - BOT/MJ/UD/556 (SAD265532P)

Course Name: Practical - BOTANICAL TECHNIQUES

Course type: Major Mandatory Discipline Specific Course

Credit: 2, Contact Hours: 60 clock hours, 4 hours/ week

Marks: 50, Internal assessment: 20, External assessment: 30

Unit I: Microscopy: Compound Microscope and its parts, their functions; Light Microscopy, Phase contrast Microscopy, flow cytometry and confocal microscopy in karyotype analysis. Principles, instrumentation, working and applications of - Fluorescence microscope, TEM, SEM; Biological sample preparation for electron microscopy SEM and TEM. Micrometry.

Unit II: Stains and Staining: Preparation and use of various stains used in botanical studies - Saffranine, Crystals Violet, Light Green, Erythrosine, Acetocarmine, Fuelgen, Basic Fucschin, Lactophenol, Cotton Blue, Iodine, Sudan IV, Fluoroglucinol, Carbolic acid etc. Sectioning and Maceration, Microtomy and Histochemistry.

Unit II: a) Ethical and Legal issues in Research: Legal permissions for collection of biological material from Local Biodiversity committees, Forest Department, State Biodiversity Board and National Biodiversity Authority.

b) Plant Collection and Preservation - Plant collection techniques, Voucher specimens, Herbarium techniques, Liquid preservation, Authentication of specimens, etc.

Sampling of Plant materials for Phytochemistry, DNA finger printing, Tissue Culture, Cytological, pathological studies etc.

Unit IV: Laboratory Techniques: Principles, instrumentation, working and applications of - UV-VIS spectrophotometry; IR (infra-red) spectrophotometry; Spectrofluorometry; Luminometry; Atomic spectrophotometry; Mass spectrometry; ESR (electron spin resonance) and NMR (nuclear magnetic resonance), Ultracentrifugation, TLC, fractionation, Electrophoresis, PCR, GISH, FISH techniques.

Unit V: Biostatistics: Calculation of mean, variance, standard deviation, standard error, coefficient of variation and to use 't' test for comparing two means related to ecological data. Hypothesis testing: Theory of errors – Type I and Type II errors, Null Hypothesis, z-test, Test of significance. lay out of field experiments.

Introduction to ANOVA, One-way & two way ANOVA, Dunett's test. Randomized Block Design and Latin Square. (5 problems to be solved in each category)

Suggested Readings:

1. Bauman R. P. Absorption Spectroscopy. John Wiley, New York Dixon R.N. Spectroscopy and Structure. Mathuen, London Sacks R.D. Emission Spectroscopy. John Wiley, New York.
2. Bell R. J. Introductory Fourier Transform spectroscopy. Academic Press, New Yrk. Colthup N.B., Daly L. H. and Wiberley S.E. Introduction to Infra-red and Raman Spectroscopy 2nd Ed. Academic Press. New York.
3. Dean J. and Rains T. Flame emission and atomic absorption. Dekker, New York. Brech F. Analysis in instrumentation. Vol. 6. Plenum, New York.
4. Grob R. L. Modern Practices of Gas Chromatography. 2nd Ed. John Wiley, New York.
5. Guilbault G. G. Practical Fluorescence: Theory, methods and Techniques. Dekker, New York.
6. Hames B. D. and Rickwood D. Gel electrophoresis of Proteins: A practical Approach 2nd Ed. IRL Press, Oxford.
7. Jensen Wiliam A. 2015, Botanical histochemistry- Principles and Practice-Agri-Horti Press New Dehli.
8. Kolthoff I. M. and Elving P. J. Treatise on analytical Chemistry, Wiley Interscience, New York.
9. Mungikar, A. M. (2003) Biostatistial Analysis. Saraswati Printing Press. Aurangabad.
10. Paterson D. D. 2008, Statistical Techniques in Agricultural research, J.V. Publishing House Jodhpur.
11. Pesez M and Bartos J. Colorimetric and Fluorometric Analysis of Organic Compounds and drugs, Dekker, New York. Becker R.S. Theory and interpretation of fluorescence and phosphorescence, Wiley interscience, New York.
12. Plummer David T. An Introduction to Practical Biochemistry-Third Edition- Tata Macgraw Hill. *Tata McGraw Hill*, New Delhi, 1990.
13. Senger R. S. Gupta Shalini, Sharma A. K., 2011, Laboratory Manual On Bioechonology- Studium Press India PVT LTD, New Dehli-2000
14. Sharma, B.K. Principal of analytical chemistry, Merut Publication, Merut.
15. Simpson C. F. Techniques in liquid chromatography, Wiley-Heyden, New York.
16. Watson I. J. Introduction to Mass spectroscopy, Raven, New York. Giddings J.C. Principles and Theory, Dynamics of Chromatogtraphy Part I Dekker, New York.
17. Willard H. F., Merritt L. L., Dean, J. A. and Settle F. A. Instrumental Method of analysis. CBS Publishers and distribution, New Delhi.18.
18. Williams D. A. R. and Mowthorpe D. J. Nuclear Maganatic Resonance Spectroscopy. John Wiley, New York.

Course Code: - BOT/DSE/UD/557 - (SBD2655542T)

Course Name: Crop Genetics and Plant Breeding – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit I: Heterosis breeding:

Historical aspects, Interbreeding depression, Homozygous and heterozygous balance, Genetic basis of inbreeding, Genetic and physiological basis of heterosis, Heterosis and plant breeding.

Unit II: Mutation Breeding:

Mutagenesis, mutagens, Physical mutagens, ionizing and non-ionizing radiations, radio-sensitivity, cytological and genetic effects, chemical mutagens, mutagenic compounds, mode of action, molecular basis of mutations, mutagenic treatment schedules, Screening of mutation in population, mutation frequency, Frequency and spectrum of mutants, micro and macro mutants, mutagenic effectiveness and efficiency, environmental mutagenesis repair mechanism, Ames test, *In vitro* site directed mutagenesis.

Unit III: Resistance breeding:

i) **Disease resistance** - nature, mechanism of resistance, methodology problems and achievements.
ii) **Insect resistance:** Nature, mechanism of resistance, methodology, problem and achievements.
iii) **Drought resistance**: Importance, types, nature of resistance methods and examples.

Unit IV: Distant Hybridization:

Importance, Interspecific, intergeneric gene transfers, methodology, problem and remedial measures, Man-made species.

Unit V: 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*.

Suggested Reading:

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

Course Code: - BOT/DSE/UD/558 -(SBD265542P)

(Practical Based on BOT/DSE/UD/557)

Course Name: Practical - Crop genetics and Plant breeding-II)

Course type: Discipline Specific Elective Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Induction of polyploidy in crop plants.
2. Study of seed protein profile by native and SDS-PAGE.
3. Estimation of leaf proteins, seed proteins in diploids and polyploids.
4. Designing of filed experiments.
5. Mutagenesis: Introduction of mutations through physical / Chemical mutagenic treatments and raising M1 & M2 generations. Assess in the effect of mutagens on different M1 parameters.
6. Study of mutagenesis data published in different journals and arriving at logical conclusions by providing theoretical reasons.
7. Report submission and deposition of rare seeds of wild plants from your area during practical exams.

Course Code: - BOT/DSE/UD/559 -(SBD265552T)

Course Name: MYCOLOGY AND PLANT PATHOLOG – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Applied Mycology

UNIT – I: Diversity of Fungi

1. Diversity of Fungi – General account
2. Fungi in diversified habitats – soil water and air
3. Fungi on plant surface – Phyllosphere and Rhizosphere
4. Biology of some important fungi: *Saccharomyces, Aspergillus*
5. Isolation, identification, selection and strain improvement of some useful fungi.

UNIT – II: Biofertilizers

1. Glomeromycota – Recent trends in Mycorrhizal taxonomy
2. Isolation and multiplication of mycorrhizae; role in crop productivity and forestry.
3. Phosphate solubilizing fungi (PSF)

UNIT – III: Mushroom

1. General account of Oyster, White button, Paddy straw, Morels, Truffles and Poisonous mushrooms.
2. Cultivation and economics of *Agaricus bisporus, Pleurotus*
3. Medicinal and nutritional value of edible and poisonous mushrooms.
4. Effect of environmental, nutritional and chemical factors on mushroom cultivation (intensive and extensive cultivation methods).

UNIT – IV: Fungi as Biopesticides

1. Application of Biotechnology in disease management
2. VA Mycorrhiza
3. Fungi in plant disease control
4. Selection, production and formulation of fungal biopesticides and commercial use of biocontrol agents.
5. Exploitation of biocontrol agents by genetic manipulation

UNIT – V: Fungal Biotechnology

1. Fermentation methods and biomass production of fungi, growth kinetics, fermenter system scale up, fermentation processes.
2. Yeast genome – genetic analysis of yeast; Baker's yeast, food and feed yeasts Glycerol and adhesive, bio-polymer from yeasts.
3. General account of production and application of industrial fungal enzymes (amylases, cellulases, pectinases and chitinases).
4. General account of production and application of primary metabolites (Vitamins and Proteins).
5. General account of production and application of secondary metabolites (antibiotics, mycotoxins, pigments and alkaloids).
6. Environmental and regulatory aspects of using genetically modified microbes in the field.

Course Code: - BOT/DSE/UD/560 -(SBD265552P)

(Practical based on BOT/ DSE/UD/ 559)

Course Name: Practical - MYCOLOGY AND PLANT PATHOLOGY – II

Course type: Discipline Specific Elective Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Collection and preservation of diseases specimens.
2. Preparation of Media, stains and isolation of Bacteria from infected plant.
3. Investigation of diseases caused by Bacteria, Phytoplasma, Viruses.
4. Study of Non parasitic diseases.
5. Virulence test for pathogens.
6. Production and assay of macerating enzymes.
7. Production and assay of polygalacturonase, cellulolytic enzymes, amylase.
8. Study of toxin production.
9. Effect of toxin on Seed Germination, Leaf Necrosis, Seedling.
10. Extraction and estimation of pigments in healthy and diseased plants.
11. Visits to fields for study of diseases.

Course Code: - BOT/DSE/UD/561 -(SBD265562T)

Course Name: Taxonomy of Angiosperms – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

UNIT-I: Species: Various 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:** Principles of Plant Nomenclature; Scientific names: legitimate and illegitimate names, 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: a) **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. Contribution of "BAMU" Herbarium.

c) Botanic Gardens: Definition, criteria, history and role of botanic gardens, special types of botanic gardens: Arboretum, Pineatum, Orchidarium, Bambusetum, Fernary. Important Botanic Gardens in India and World.

UNIT-VI: Comparative account on distribution, floral morphology, interrelationships of families belonging to the following order as per APG IV system of classification:

a) Nympheales	b) Magnoliales	c) Arecales	d) Asparagales,
e) Liliales	f) Poales	g) Zingiberales	h) Ranunculales
i) Fabales	j) Rosales		

Suggested Reading:

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) Koeltz Vesentific 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.
https://academic.oup.com/botlinnean/article/181/1/1/2416499
https://en.wikipedia.org/wiki/APG_IV_system#:~:text=The%20APG%20IV%20system%20of,Angiosperm%20Phylogeny%20Group%20(APG).

Course Code: - BOT/DSE/UD/562 - (SBD265562P)

(Practical based on BOT/ DSE/UD/ 561)

Course Name: Practical - Taxonomy of Angiosperms – II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

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. Semi-permanent pollen preparations by acetolysis method and study of different pollen morphotypes.
6. Study of plant surface attributes with the help of SEM photographs.
7. Descriptions, sketching, classification and identification of at least 30 families represented in local flora.
8. 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* etc.
9. Several One-day botanical excursions to botanically rich locations.
10. Botanical excursion of about one week to any botanically rich location preferable outside the State.

Course Code: - BOT/DSE/UD/563 - (SBD265572T)

Course Name: Advanced Plant Physiology and Biochemistry – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/week

Marks: 75, Internal assessment: 30, External assessment: 45

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 fractionation: 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.

Suggested Readings:

1. Bajrachrys D. Experiment in Plant Physiology, Narosa Publishing House, New Delhi.
2. Bidwell R. G. S., Plant physiology: Mac Millan Publishers Co., New York.
3. Bormer, J. and Galston, A. W., Principles of plant physiology,
4. Hess, Plant physiology, Narosa Publishing House, New Delhi.
5. Datta, S. C., Plant Physiology, Willey Eastern Limited, Culcutta.
6. Devlin, R. M. and Hostan, F. H., Plant physiology, CBS Publishers and Distributors, New Delhi.
7. Fairley, J. L. and Kilgon, G. L., Essentials of Biological Chemistry, Earr west Press Pvt. Ltd., Delhi.
8. Goodwin T. W. & E. I. Mercer (2003) Introduction to Plant Biochemistry, CBS, New Delhi
9. Hess, D. Plant Physiology, Narosa Publishing House, New Delhi.
10. ICAR Handbook of Agriculture, ICAR, New Delhi.
11. Jayraman, J., Laboratory Manual in Biochemistry, New Age International Publishers, Mumbai.
12. Lehninger, A. L. Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
13. Mertz, E. T., Vakils, Elementary Biochemistry, Fetter and SimsonsPvt Ltd. Mumbai.

14. Mukharji S., A. K. Ghosh, Plant Physiology, New Central Book Agencies, Kolkatta.
15. Mukharji, S. and Ghosh, A. K. Plant Physiology. New Central Book Agencies, Kolkatta.
16. Mungikar, A. M. Bibliography of leaf protein in Marathwada University.
17. Nels R. Lersten (2014) Flowering Plant Embryology, Wiley, New Delhi
18. Noggle G. R. and Fritz, G. S., Introductory plant physiology, Prentice Hall, USA.
19. Pandey S. N. & Sinha B. K., Plant Physiology, Vikas Publishing House, New Delhi
20. Pine, N. W. (1971) Leaf protein, its preparation, quality and use, Blackwell Scientific Publ. U. K.
21. Salisbury F. N. and C. W. Ross, Plant physiology: CBS Publishers and Distributors, New Delhi.
22. Slyter, R. O. Plant Water Relationships, Academic Press, New York.
23. Telek, H. and Graham, L. T. (1983) Leaf protein concentrates, AVI, Publishing Co., USA.
24. Vaidya, V. G., Sahasrabuddhe, K. R. and Khupse, V. S. Crop production and field experimentation Continental Prakashan, Pune - 30.
25. Wilkins M. B., Advanced plant physiology, English Language Book Society, London.

Course Code: - BOT/DSE/UD/564 -(SBD265572P)

(Practical based on BOT/DSE/UD/563)

Course Name: Practical - Advanced Plant Physiology and Biochemistry – II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Estimation of crude protein, crude fat and crude fiber.
2. Estimation of ash acid soluble / insoluble ash, Nitrogen free extracts and total carbohydrates.
3. Estimation of cell wall constituents, ADF, NDF, cellulose, hemicellulose, lignin etc.
4. Estimation of calcium by titration method.
5. Estimation of phosphorus by Subba Rao and Fiske Method,
6. Growth analysis: AGR, RGR, NAR, LAR, LAI, CGR and LAD.
7. The process of GCF and extractability of dry matter and Nitrogen.
8. Preparation of LPC, by heat coagulation, acid coagulation and fermentation.
9. Preparation of cytoplasmic and chloroplast LPC by differential heat coagulation.
10. Preparation of TCM using DPJ and Inoculation of explant.