

**S.S.JAIN SUBODH P.G. (Autonomous) COLLEGE, JAIPUR
(Affiliated to University of Rajasthan)**



SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

DEPARTMENT OF BOTANY

Master of Science

M.Sc. Botany course Structure

M.Sc. Botany course will be completed in two academic years; There will be two semesters in each year. The medium of instruction and examination shall be English only.

First Year

First Semester

1. MBOT 101 Cell Biology and Evolution
2. MBOT 102 Morphology and Diversity of Non Vascular Plants
3. MBOT 103 Biology and Diversity of Microbes
4. MBOT 104 Plant Ecology and Environment
5. MBOT 151 PRACTICAL (MBOT 101 & MBOT 102)
6. MBOT 152 PRACTICAL (MBOT 103 & MBOT 104)

Second Semester

1. MBOT 201 Genetics and Plant Breeding
2. MBOT 202 Morphology and Diversity of Vascular Plants
3. MBOT 203 Phytopathology
4. MBOT 204 Plant Physiology and Metabolism
5. MBOT 251 PRACTICAL (MBOT 201 & MBOT 202)
6. MBOT 252 PRACTICAL (MBOT 203 & MBOT 204)

Second Year

Third Semester

1. MBOT 301 Molecular Biology
2. MBOT 302 Taxonomy of Angiosperms
3. MBOT 303 Morphology and Developmental Anatomy of Angiosperms
4. MBOT 304 Core Electives I: Advanced Plant Pathology-I /
Core Electives II: Seed Science and Technology-I/
Core Electives I: Advanced Plant Physiology - I
5. MBOT 351 PRACTICAL (MBOT 301 & MBOT 302)
6. MBOT 352 SEMINARS AND PRACTICAL (MBOT 303 & MBOT 304)

Fourth Semester

1. MBOT 401 Embryology of Angiosperms
2. MBOT 402 Plant Resource Utilization and Ethnobotany
3. MBOT 403 Plant Biotechnology and Genetic Engineering
4. MBOT 404 Core Electives II: Advanced Plant Pathology-II /
Core Electives II: Seed Science and Technology-II/
Core Electives II: Advanced Plant Physiology – II
5. MBOT 451 PRACTICAL (MBOT 401 & MBOT 402)
6. MBOT 452 PROJECT WORK/ TRAINING/ PRACTICAL (MBOT 403 & MBOT 404)

Each semester will have continuous assessment, which will include internal assessment in theory and practicals by internal examination and overall performance assessed by seminar, viva-voce, classroom attendance / Quiz/ home assignment etc.

Syllabi tour organized by the college in any one semester shall be compulsory. Students are required to submit 20 herbarium sheets of plant collection made in the excursion and 5 permanent slides of plant material. Practical records submission is also essential in each practical examination.

Course Structure and Scheme of Examination

First Semester

S.no	Subject Code	Course Title	Course Category	EoSE duration		EoSE assessment			
				Theo.	Prac	EX.	In.	Min.marks	Max.marks.
1.	MBOT 101	Cell Biology and Evolution	CCC	3	0	70	30	36	100
2.	MBOT 102	Morphology and diversity of non-vascular plants	CCC	3	0	70	30	36	100
3.	MBOT 103	Biology and diversity of microbes	CCC	3	0	70	30	36	100
4.	MBOT 104	Plant Ecology and environment	CCC	3	0	70	30	36	100
5.	MBOT 151	Practical I based on MBOT 101&102	CCC	0	4	60	40	40	100
6.	MBOT 152	Practical II based on MBOT 103&104	CCC	0	4	60	40	40	100

Second Semester

S. No.	Subject Code	Course Title	Course Category	EoSE duration		EoSE assessment			
				Theo.	Prac.	EX.	In.	Min. marks	Max.marks.
1.	MBOT 201	Genetics and Plant breeding	CCC	3	0	70	30	36	100
2.	MBOT 202	Morphology and diversity of vascular plants	CCC	3	0	70	30	36	100
3.	MBOT 203	Phytopathology	CCC	3	0	70	30	36	100
4.	MBOT 204	Plant Physiology and metabolism	CCC	3	0	70	30	36	100
5.	MBOT 251	Practical I based on MBOT 201&202	CCC	0	4	60	40	40	100
6.	MBOT 252	Practical II based on MBOT 203&204	CCC	0	4	60	40	40	100

Third Semester

S. No.	Subject Code	Course Title	Course Category	EoSE duration		E0SE assessment			
				Theo.	Prac.	EX.	In.	Min.marks	Max.marks.
1.	M BOT 301	Molecular Biology	CCC	3	0	70	30	36	100
2.	MBOT 302	Taxonomy of Angiosperm	CCC	3	0	70	30	36	100
3.	MBOT 303	Morphology and developmental anatomy of angiosperm	CCC	3	0	70	30	36	100
4.	MBOT 304 A/B/C	Adv. Plant Patho. I / Seed Sci. and Tech.I / Adv. Plant Physio. I	ECC	3	0	70	30	36	100
5.	MBOT 351	Practical I based on MBOT 301&302	CCC	0	4	60	40	40	100
6.	MBOT 352 A/B/C	Practical II based on MBOT 303 &304 (A/B/C)	ECC	0	4	60	40	40	100

Fourth Semester

S. No.	Subject Code	Course Title	Course Category	EoSE duration		EoSE assessment			
				Theo.	Prac.	EX.	In.	Min. marks	Max.marks.
1.	MBOT 401	Embryology of Angiosperm	CCC	3	0	70	30	40	100
2.	MBOT 402	Plant Resource Utiliza. and Ethano.	CCC	3	0	70	30	40	100
3.	MBOT 403	Plant Biotech. and Genetic Eng.	CCC	3	0	70	30	40	100
4.	MBOT 404 A/B/C	Adv.Plant Patho.-II / Seed Sci. and Tech.II / Adv. Plant Physio.-II	ECC	3	0	70	30	40	100
5.	MBOT 451	Practical I based on MBOT 401 & 402	CCC	0	4	60	40	40	100
6.	MBOT 452 A/B/C	Practical II based on MBOT 403 & 404 (A/B/C) Project work / Seminar	ECC	0	4	60	40	40	100

EoSE-End of Semester Examination/CCC:-Core Course/ECC-Core Elective Course

I SEMESTER

MBOT-101 Cell Biology and Evolution

Unit-I

Structural organization and function of Organelles: Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, structure and function of Cytoskeleton and its role in motility.

Membrane Structure and Function: Structure of model membrane, lipid bilayer and membrane protein (Diffusion, Osmosis, Ion channels, active transport and membrane pumps).

Intracellular compartments and transport: Mechanism of protein sorting in peroxisomes, nucleus, chloroplast, mitochondria, ER and regulation of intracellular transport. (15hrs)

Unit -II

Cell division and cell cycle: Mitosis and Meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

Cell signaling hormones and their receptors: Cell surface receptor, second messengers, signaling through G-protein coupled receptors, signal transduction pathway (cyclic AMP, phospholipase C, Ca⁺² calmodulin & receptor tyrosine kinase pathway).

Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins. (15hrs)

Unit -III

Apoptosis (Programmed Cell Death): Mechanism of apoptosis, apoptosis triggered by internal and external signals, apoptosis inducing factors, cancer, oncogenesis.

Emergence of evolutionary thoughts: Lamarck, Darwin- concepts of variation, adaptation, struggle, fitness and natural selection, Mendelism, spontaneity of mutations.

Origin of cells and unicellular evolution: Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin and Haldane, Experiment of Miller (1953), The first cell, Evolution of prokaryotes, Origin of eukaryotic cells, Evolution of unicellular eukaryotes. (15hrs)

Unit -IV

Paleontology and Evolutionary History: The evolutionary time scale, Eras, Periods and Epoch. Major events in the evolutionary time scale, Origins of unicellular and multicellular organisms, Major groups of plants and animals.

Population Genetics: Populations, Gene pool, Gene frequency, Hardy-Weinberg law, concepts and rate of change in gene frequency through natural selection, Migration and random genetic drift, Adaptive radiation, Isolating mechanisms, Speciation, Allopatricity and Sympatricity, Convergent evolution, Sexual selection, Co-evolution. (15hrs)

Suggested Laboratory Exercises:

1. EM study of cell organelles
2. Fluorescence staining with FDA for cell viability
3. Cell wall staining with calcofluor white
4. Study of stages in cell cycle
5. Mitosis and Meiosis
6. Histochemical localization of protein, carbohydrate, fats, starch, lignin, nucleic acids
7. Demonstration of SEM and TEM
8. Isolation of chloroplast and study of its percentage intactness
9. Isolation of chloroplast and study of light reaction system.
10. Isolation of Mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH).
11. Hardy- Weinberg numerical.
12. Any other practical based on theory syllabus.

Suggested readings:

1. Krishnamurthy, K.V. 2000. Methods in cell wall Cytochemistry. CRC Press, Boca Raton, Florida.
2. Reeve, ECR. 2001. Encyclopedia of Genetics, F.D. Publication, Chicago, USA,

3. De D. N. 2000. Plant Cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
4. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. (VIII Edition). Lippincott Williams and Wilkins, Philadelphia.
5. Cooper, G. M. and Hausman, R.E. 2009. The Cell: A molecular approach. (V Edition). ASM press and Sunderland, Washington D.C. Sinauer Associates, MA.
6. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. 2009. The world of the cell. VII Edition. Pearson Benjamin Cummings Publishing. San Francisco.
7. Kleinsmith, L.J. and Kish, V. M. 1995. Principles of Cell and Molecular Biology. 2nd Edition. Harper Collins College Publishers, New York, USA.
8. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
9. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.
10. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
11. Griffiths, A.J.F. *et al.* 2000. An introduction to geneic analysis. W.H. Freeman and Company, New York, SA.
12. Rana, S.V.S. 2012. Biotechniques, theory and practices (Third edition), Rastogi Publications, Meerut
13. Roy, S.C. and De, K.K. 1999. Cell Biology. New Central Book Agency (P) Ltd. Calcutta.
14. Hartl, D. L. 1994. Genetics. Jones and Bartlett Publishers International, USA

MBOT 102 Morphology and Diversity of Non Vascular Plants

Unit -I

Algae: General characteristics, habitats, thallus organization, cell ultrastructure, reproduction (sexual, asexual & vegetative), lifecycle patterns, classification schemes, Salient features of Cyanophyta, Chlorophyta, Bacillariophyta, Xanthophyta, Phaeophyta and Rhodophyta, with special reference to *Spirulina*, *Dunaliella*, *Pinnularia*, *Laminaria* and *Batrachospermum*. Economic importance of algae specially in industries, food, fodder, biofertilizers, biofuels.
(15hrs)

Unit -II

Fungi: General characters, life cycle patterns, ultra-structure, mycelial growth, cell wall composition, nutrition (necrotrophs, biotrophs and symbionts), methods of reproduction (Asexual, Sexual). Heterothallism, heterokaryosis, brachymeiosis, parasexuality. Recent trends in classification and phylogenetic relationship among fungal groups.
(15hrs)

Unit -III

General account of *Mastigomycotina*, *Zygomycotina*, *Ascomycotina*, *Basidiomycotina*, & *Deuteromycotina* with special reference to *Peronospora*, *Rhizopus*, *Neurospora*, *Polyporus*, *Drechslera* & *Colletotrichum*. Economic importance of fungi in industries, medicines and as food, fungi as biocontrol agents, poisonous fungi, mycorrhizae.
(15hrs)

Unit -IV

Bryophyta : Distribution, morphology, structure, reproduction & classification of Bryophytes. General account of *Marchantiales*, *Jungermanniales*, *Anthocerotales*, *Sphagnales*, *Funariales*, & *Polytrichales* with special reference to *Plagiochasma*, *Notothylus*, *Physcometrella Patens* and *Polytrichum*. Fossil Bryophytes. Origin and evolution of bryophytes, economic importance of bryophytes, role of bryophytes in succession.
(15hrs)

Suggested laboratory exercises:

Morphological study of representative members of algae, Fungi and Bryophytes present in your locality in their natural habitat with special references to:

- **Algae:** *Microcystis*, *Spirulina*, *Rivularia*, *Dunaliella*, *Aulosira*, *Pediastrum*, *Hydrodictyon*, *Ulva*, *Pithophora*, *Stigeoclonium*, *Gelidium* and *Batrachospermum*; isolation and culture of algae.
- **Fungi:** *Stimonitis*, *Peronospora*, *Pythium*, *Albugo*, *Piobolus*, *Yeast*, *Emericella*, *Chaetomium*, *Pleospora*, *Morchella*, *Melampsora*, *Phallus*, *Polyporus*, *Drechlera*, *Curvularia*, *Phoma*, *Penicillium*, *Aspergillus*, *Colletotricum*, *Fusarium* and *Alternaria*;
- Isolation and culture of fungi using moistened blotters, PDA and sabouraud's dextrose agar media.
- **Bryophyte:** *Plagiochasma*, *Pellia*, *Physcometrella Patens*, *Notothylus* and *Polytrichum*.

Suggested Reading:

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). *Introductory Mycology*, John Wiley & Sons Inc.
2. Anderson, R.A. (2005) *Algal Culturing Techniques*. Physiological Society of America. Elsevier Academic Press, USA.
3. Fritsch, F.E. (1933, 1945). *The Structure and Reproduction of Algae* Vols. Cambridge University Press. Cambridge, UK.
4. Fritsch, F.E. (1945). *The structure and Reproduction of Algae*. Vol II. University Press, Cambridge, UK.
5. Caves, F. Inter-relationship of the Bryophyta, *New Phytologist*, Reprint No. 4. 1911, Indian Reprint. S.R. Technician, Book House, Patna, 1981, pp. 212.
6. Kashyap, S.R. (1932) *Liverworts of Western Himalayas and Punjab Plains* (VII. I & II) Reserchco Publication, New Delhi, pp. 137, pp. 129.
7. Richardson, D.H.S. *Biology of Mosses*, (1981). Blackwell Scientific Publication Oxford, pp. 220.
8. Bold, H.C., Alexopoulos, C.J. and Delevoryas, T. (1980): *Morphology of plant and Fungi* (4th Ed.) Harper & Foul CO., New York.
9. Ghemawat, M.S., Kapoor J.N., and Narayan, H.S. (1976): *Latest book of Algae*. Ramesh book Depot, Jaipur. I
10. Gilbert, M. *Smith Cryptogamic Botany*, vol I & II (2nd EDITION) 1985. Tata Mc Graw hill pub. Co. New Delhi
11. Puri, P. *Bryophytes* (1985) Atmaram & sons, Delhi. Lucknow
12. Sharma, P.D. (1996) *Introduction to Bryophytes*, Ramesh Book depot, Jaipur

MBOT 103

Biology and Diversity of Microbes

Unit -I

Introduction and classification: History, scope and developments since 20th century. Bergey's manual of systematic bacteriology. Nutritional classification of microorganisms, Modern trends in classification (ribotyping, nucleic acid hybridization, RNA fingerprinting, molecular chronometer). (8hrs)

Microbial diversity: Occurrence, salient features of following- Gram negative bacteria, spirochaetes, aerobic, anaerobic and microaerophilic bacteria, rickettsias and anoxygenic phototrophs, oxygenic phototrophs, mycobacteria, actinomycetes, chlamydias, mycoplasma, arachebacteria, methanogens, extremophiles – halophiles and thermophiles. (10 hrs)

Unit -II

Morphology, ultra structure and cultivation of bacteria: Morphology and ultra structure of bacteria, cytoplasmic inclusions, plasmids and endospores, anaerobic and aerobic culture media, growth curve, growth kinetics, batch, continuous culture, growth measurements and pure culture techniques. (10 hrs)

Viruses: Classification and nomenclature with cryptograms, properties and structure of viruses, life cycle and pathogenesis of following- RNA viruses-retero, rhabdo, hepatitis, swine flu, DNA viruses – Pox, herpes, measles. Plant viruses-cauliflower mosaic and turnip yellow mosaic. (8 hrs)

Unit -III

Immunology: General account of immunity, properties of antigens and antibodies, antibody structure and function, affinity and antibody specificity, monoclonal antibodies and their uses, antibody engineering, serology, vaccination and vaccines, interferon, antigen-antibody interaction, MHC molecule, antigen processing and presentation, activation and differentiation of B and C cell receptors, humoral and cell-mediated immune responses. (12hrs)

Unit -IV

Application of microbiology: Agriculture and waste management, Microbial fermentation and production of small and macromolecules: production of alcohol, organic acids, amino acids, enzymes, antibiotics, mineral recovery. Contamination and spoilage of food products, application of microbial enzymes in food industries, microbiology of fermented milk products and food preservation method.

Biodegradation, bioremediation and biodeterioration. Brief account of biofilms, biochips, biosensors and biosurfactants. (12hrs)

Suggested Laboratory Exercises

1. Preparation of culture media-liquid and solid media, enrichment, selective, preparation of slant, deep tube and plate culture.
2. Isolation of pure culture by pour plate, serial dilution and streak plate method.
3. Study of growth curve.
4. Effect of pH, temp, osmolarity and Oxygen, UV, dessication on growth of bacteria.
5. Sterilization methods.
6. Methods of quantitative estimation of microorganisms.
7. Total counts (haemocytometer method), viable counts (plate count), WBC and RBC counts.
8. Methods of staining bacteria (simple staining, Gram's staining, negative staining).
9. Endospore staining.
10. Fermentative production of ethyl alcohol by Yeast.
11. Extraction and detection of aflatoxin in infested foods.
12. Blood grouping and Rh factor.
13. Haemoglobin estimation.
14. To study spontaneous mutations by replica plating.
15. To study induced mutations in bacteria.
16. Antibiotic bioassay (gradient plate technique and disc method).
17. Testing of milk by MBRT, turbidity test for milk.
18. Qualitative estimation of Phosphorus and Calcium in milk.
19. Determination of most probable number (MPN).
20. Coliform test for milk/water
21. Isolation of microorganisms from air, water, soil and rhizosphere microflora.

Suggested readings:

1. Frazier, W.C. and Westhoff, D.,C. (1998). Food Microbiology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
2. Reed, G. 2004 (5th Ed.) Industrial Microbiology. CBS Publishers, AVI Publishing Company, New Delhi.
3. Edward, D. Schroeder, Juana, B. Eweis, 1998. Bioremediation principles. Tata Mc Graw Hill, Publishing Company Ltd., New Delhi.
4. Stainer, R.Y., Ingraham, John L. and Mark L. Wheelispagex. 1992. General Microbiology. Mc Millian Press, UK.
5. Atlas, Ronald, M. 1997. Principle of Microbiology. Tata Mc Graw Hill, Publishing Company Ltd. New Delhi.
6. Peleczar, Michael, J., Chan, E.L.S. and Krieg, N.R. 1996. Microbiology, Tata Mc Graw Hill, Publishing Company Ltd., New Delhi.
7. Michael, T. Madigan, Martinko, Joh. M. and Parker, Jack 2010 (13th Ed.) Brock's Biology of Microorganisms. Prentice Hall, US.
8. Black J.G. 1995. Microbiology principles and applications. John Wiley, Prentice Hall, US.
9. Michael, R. 1999. Introduction of Environmental Microbiology. ASM books, Washington Dc.
10. Graham, Sir, Wilson, S. and Miles, Sir Ashley, Vol. I. Principles of Bacteriology, Virology and Immunity. 1975 (6th Ed.). Edward Arnold Publisher Ltd., London.
11. Collins, C.H. and Patrica, M.Lyne 1976. Microbiological methods. Butter worth and Co. Publisher Ltd., Boston, US.
12. Maier, Raina M., papper, Lan L., Gerba, Carles P. 2009 (IInd edition) Environmental Microbiology. Academic Press, Elsevier, London, U.K.
13. Manual of Microbiology: Tools and Techniques; Kanika Sharma. Ane books. New Delhi. 2007
14. Textbook of Microbiology; Kanika Sharma. Ane books. New Delhi. 2011

MBOT 104

Plant Ecology and Environment

UNIT-I

The Environment: Physical environment, biotic environment, biotic and abiotic interactions.

Population: Characteristics of population, population size and population growth curve, population regulation; life history strategies (r and k selection); concept of metapopulation-deme and dispersal, interdemec extinctions, age structured populations.

Species interactions: types of interactions; Competition and coexistence, intra-specific interactions, interspecific interactions, scramble and contest competition model, mutualism, commensalism and allelopathy, prey-predator interactions. (15hrs)

UNIT-II

Vegetation organization: Concepts of community and continuum, community coefficients, interspecific associations, ordination, species diversity and pattern diversity in community, Diversity indices, concept of habitat and ecotone, ecological niche.

Vegetation development: Temporal changes (cyclic and non-cyclic), mechanism of ecological succession (relay floristic and initial floristic composition), succession models (facilitation, tolerance and inhibition models), Changes in ecosystem properties during succession, concept of climax. (15hrs)

UNIT-III

Ecosystems: Ecosystem structure and function. Grassland and Detritus food chain in freshwater ecosystems, food webs, Energy flow models, Productivity of various ecosystems of the world and global biogeochemical cycles of carbon, nitrogen and phosphorus, Ecosystem Management: Homeostasis and cybernetics of ecosystem, Resilience of ecosystem, Restoration of degraded ecosystems. (15hrs)

UNIT-IV

Biomes, Biodiversity and Conservation: Major biomes of the world, biogeographical zone of India Biodiversity assessment (local, national and global), status of biodiversity, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. conservation (ex-situ and in situ). International Conservational organizations, biodiversity act of India and related international conventions. Sustainable development and natural resource management in changing environment. Brief account on bioremediation and phytoremediation. (15hrs)

Suggested Laboratory Exercises

1. To determine minimum size and number of quadrat required for reliable estimate of biomass in grassland.
2. To compare protected and unprotected grassland stands using community coefficients (similarity indices).
3. To estimate IVI of the species in a grassland/woodland using quadrat method.
4. To determine gross and net phytoplankton productivity by light and dark bottle method.
5. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
6. To determine the Water holding capacity of soils collected from different locations.
7. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.
8. To estimate and dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Wrinkler's method.
9. To estimate chlorophyll content in SO₂ fumigated and unfumigated plants leaves.
10. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
11. To study environmental impact of a given development activity using checklist as a EIA method.

Suggested Readings

1. Smith, R.L. 1996. Ecology and Field Biology, Harper Collins, New York.
2. Muller-Dombois, D. and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
3. Begon, M. Harper, J.L. and Towsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
4. Ludwig, J. and Reynolds, J.F. 1988. Statistical Ecology. John Wiley and Sons.
5. Odum, E.P. 1971. Fundamentals of Ecology, Saunders, Philadelphia.
6. Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
7. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology, Benjamin/Cummings Publications Company, California.
8. Kormondy, E.J. 1996. Concepts of ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.

9. Chapman, J.L. and Reiss, M.J. 1988. Ecology, Principles and Applications, Cambridge University Press, Cambridge, U.K.
10. Molan, B. and Billharz, S. 1997. Sustainability Indicators, John Wiley Sons, New York.
11. Heywood, V.H. and Watson, R.T. 1985. Global Biodiversity Assessment. Cambridge University Press.
12. N.S. Subrahmanyam and A.V. S.S. Sambamurty. 2000. Ecology. Narosa Publishing House, Jaipur.
13. S.K. Maiti. 2004. Handbook of Methods in Environmental Studies Vol. 1 & 2 ABD Publisher, Jaipur.
14. J.L. Chapman and M.J. Reiss. 1995. Ecology principles and applications. Cambridge University Press.
15. C. Faurie, C. Ferra, P. Medori and J. Devaux. 2001. Ecology Science and Practice. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- 16 G.T. Miller Jr. 2005. Essentials of Ecology. III Edition, Thomson, Brooks/Cole.

II SEMESTER

MBOT 201 Genetics and Plant breeding

Unit-I

Gene Structure and expression: Genetic fine structure, Operon concept, Introns and Exons, Cis-trans test, fine structure analysis of eukaryotes, introns and their significance, Gene family.

Inheritance and allelism: Mendalian and non-Mendalian inheritance, Gene interaction: Complementary genes (9:7), Supplementary genes (9:3:4 and 9:6:1 ratios), epistasis (12:3:1 and 13:1 ratios), Duplicate genes (15:1), Codominance, lethal genes, polygenic inheritance. Extra nuclear inheritance: cytoplasmic male sterility, inheritance of mitochondrial and chromosomal plant genes. Hardy-Weinberg law, gene frequency and genotype frequency, sex determination, sex-linked inheritance, sex limited characters and sex reversal, multiple alleles and blood group in man, genome imprinting. (15hrs)

Unit-II

Genetic recombination: Homologous and non-homologous recombinations, independent assortment and crossing over, molecular mechanism of recombination, Holiday junctions, site-specific recombination, FLP, FRT and recombination, role of Rec A and Rec BCD enzymes and other recombinations.

Mutation and Types of DNA damage: Mutagens and their effects – Physical (Radiations) and Chemical base analogues, intercalating agents, alkylating agents and others. Types of mutation – Spontaneous and induced mutations, lethal, conditional, biochemical, loss and gain of function. Base substitutions, frame shift mutation, germinal versus somatic mutation, mutations induced by transposons.

Repair mechanisms of mutational DNA damages: Direct reversal of damages, photoreactivation and dealkylation, excision repair mechanism, (NER, BER), post replication repair mechanisms (Mismatch repair and Recombination repair), SOS repair, inherited diseases and defects in DNA repair

Mutagenesis: Insertional mutagenesis, site-directed mutagenesis, in vitro mutagenesis and deletion techniques, Ames test for mutagenesis, ploidy and their genetic implications. (15hrs)

Unit-III

Chromosome mapping: Linkage map, mapping with genetic markers including RAPD, QTL, construction of molecular maps, restriction mapping – concept and technique, correlation of genetic and physical maps, mapping by using somatic cell hybrids.

Structural and numerical alterations in chromosomes: Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes. Origin, occurrence, production meiosis of haploids, aneuploids and euploids, origin and production of autopolyploids, chromosome and chromatid segregation, allopolyploids types; genome constitution and analysis, evolution of major crop plants, induction and characterization of trisomics and monosomics. (15hrs)

Unit-IV

Molecular cytogenetics: Nuclear DNA content, C-value paradox, cot curve and its significance, multigene families and their evolution, in situ hybridization – concept and techniques, computer assisted chromosome analysis. An idea about Proteomics, Genomics and Epigenomics.

Plant breeding

Genetic system and breeding methods: Selection and breeding strategies for self-pollinated, cross-pollinated and clonally propagated crop plants, breeding for crop quality, biotic and abiotic stresses, gene pyramiding for multi trait incorporation. Genetic control and manipulation of breeding systems including male sterility and apomixis. (15hrs)

Suggested Laboratory Exercises:

1. Study of Hardy-Weinberg Law using simulations.
2. Linear differentiation of chromosomes through banding techniques, such as G-banding, C-banding and Q-banding.
3. Silver banding for staining nucleolus-organizing region, where 18 S and 28S rRNA are transcribed

4. Working out the effect of mono and trisomy on plant phenotype.
5. Induction of polyploidy using colchicine
6. Different applications of colchicine.
7. Study of variations in plants due to numerical alterations in chromosomes.
8. Numericals based on inheritance and gene interactions.
9. Flow cytometry and confocal microscopy.
10. Emasculation, crossing and Bagging in crop plants.
11. Any other practical based on theory syllabus.

Suggested Readings:

1. Atherly, A.G., Girton, J. R. and McDonald, J.F. 1999. The Science of Genetics. Saunders College Publishing. Fort Worth. USA.
2. Gardner, E. J., Simmons, M.J., Snustad, O. P. Principles of Genetics, John Wiley and Sons Inc.
3. M.R. Neuman. Introduction to Molecular Biology, Genomics and Proteomics for Biomedical Engineers. CRC Press.
4. Lewin, B. Genes IX. Jones and Bartlett Publishers.
5. Burnham, C. R. 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota
6. Busch, H. and Rothblum, L. 1982. Volume X. The Cell Nucleus rDNA Part A. Academic Press.
7. Hartl, D.L. and Jones, E. W. 1998. Genetics: Principles and analysis (4th edition). Jones and Bartlett Publishers, Massachusetts, USA.
8. Khush, G. S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
9. Russel, P.J. 1998. Genetics (5th edition). The Benjamin/Cummings Publishing Company INd. USA.
10. Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: Laboratory Methods. CRC Press, Boca Ratan, Florida.
11. Sharma, A. K. and Sharma, A. 1999. Plant Chromosome Analysis, Manipulation and Engineering. Hoarwood Academic Publisher, Australia.
12. Acquaah, G. 2007. Principles of Plant Genetics and Breeding. Blackwell Publishing Ltd. USA.
13. Allard, R. W. 1999. Principles of Plant Breeding (2nd edition), John Willey and Sons.
14. Snustad, D. P. and Simmons, M. J. 2009. Principles of Genetics (V Edition). John Willey and Sons Inc. USA.
15. Klug, W.S., Cummings, M. R., Spencer, C.A. 2009. Concepts of Genetics (XI Edition). Benjamin Cummings Publishing Company INd. USA.
16. Russell, P. J. 2009. Genetics- A Molecular Approach. (III Edition). Benjamin Cummings Publishing Company INd. USA
17. Pevsner, J. 2009. Bioinformatics and Functional Genomics (II Edition). John Willey & Sons.

MBOT: 202
Morphology and Diversity of Vascular Cryptogams

Unit-I

Pteridophytes –General account, distribution, classification and inter-relationships of the Pteridophyta with special reference to Rhyniophytosida, Psilotosida, Lycoposida, Sphenosida, Pteropsida classes. Economic importance of Pteridophytes. Brief account of fossil pteridophytes classes. (15hrs)

Unit-II

Morphology, anatomy, reproduction, life history and classification of *Tmesipteris*, *Isoetes*, *Gleichenia*, *Ophioglossum* & *Azolla*; Origin and evolution of stele, heterospory and seed habit. (15hrs)

Unit-III

Gymnosperms- General account, distribution and classification of gymnosperms. Morphology, anatomy, reproduction, life history and evolutionary trends of– Cycadales, (*Zamia*), Ginkgoales (*Ginkgo*), Coniferales (*Taxus*), Welwitschiales (*Welwitschia*) Gnetales (*Gnetum*). Economic importance of gymnosperms. (15hrs)

Unit-IV

Paleobotany- History, formation and types of fossils, techniques of fossil study, Geological time scale. Brief account of Pteridospermales (*Lygenopteris*, *Medullosa*, *Caytonia*, and *Glossopteris*), brief account of cycadeoidales (*Cycadeoidea*), cordaitales (*Cordaites*). Paleobotany and evolution of vascular plants. Applied aspects of Botany, use in coal and petroleum exploration. (15hrs)

Suggested laboratory exercise:

Morphological and anatomical study of representative members of Pteridophytes and Gymnosperm in their natural habitat found in your locality with special reference Lycopodium, Isoetes, Gleichenia, Ophioglossum and Azolla in Pteridophytes. *Zamia*, *Ginkgo*, *Taxus*, *Araucaria*, *Cedrus*, *Biota* and *Gnetum* in gymnosperms, study of fossils.

Suggested Reading:

1. Parihar, N.S. 1996. Biology & Morphology of pteridophytes. Central Book Depot. Allahabad.
2. Sporne, K.K. 1991. The Morphology of Pteridophytes. B.I. Publishing Pvt, Ltd. Bombay.
3. Stewart, W.N. and Rathwell, G.W. 1993. Paleobotany and the Evolution of plants. Cambridge University Press, UK.
4. hatnager, S.P. and Moitra, A. 1996. Gymnosperm. New Age International Pvt. Ltd. New Delhi.
5. ingh, H. 1978. Embryology of Gymnosperm. Encyclopedia of Plant anatomy X. Gebruder Borntraeger. Berlin Germany
6. mith, G.M. 1955. Cryptogamic Botany Vol II. Tata Mc.Graw Hillbook Company NY
7. andey, B.P. 1993. College Botany Vol. II. S. Chand & company ltd
8. rnmold, Chester A. 2000. Introduction to Paleobotany, Agrobios, India
9. ashid, A. 2001. An Introduction to Pteridophyta (II edition) Vikash Publishing house Pvt/ Ltd, New Delhi.
10. .Sunderarjan S, 2001. Introduction to Pteridophyta, New Age International Publishers, New Delhi

MBOT 203 Phytopathology

Unit-I

Plant diseases: Introduction, general account of disease development. History of plant pathology. Nature and concept of Plant Disease. Symptoms of Plant diseases caused by plant pathogen.

Pathogenesis: Biotic and abiotic factors in pathogenesis, pathogen factors in disease development. Penetration, infection. Enzymes and Toxins in Plant Disease – Host specific and non-host specific toxin. Concept of Effectors.

(15hrs)

Unit -II

Development: Modes of infection, Mechanism of Penetration of Pathogens. Protective and defense mechanism in plants – Morphological and biochemical.

Management of Plant disease: Physical, Chemical and Biological Biopesticides, Plant Disease Clinics.

(15hrs)

Unit-III

Symptomology, identification and control of following Plant Diseases:

Fungal diseases: Wheat – Flag smut, Karnal bunt. Rust of Linseed. Tikka disease of Groundnut

Bacterial diseases: Wheat: Tundu disease. Black rot of Crucifer

(15hrs)

Unit -IV

Symptomology, Identification and Control of Following Plant Diseases:

Viral diseases: Cadang – Cadang disease of Coconut, Leaf Curl of Tomato.

Nematode disease: Root Knot of Brinjal, Ear Cockle of Wheat.

Non-Parasitic Diseases: Black Heart of Potato, Mango necrosis.

(15hrs)

Suggested Laboratory Exercises:

- Isolation of antibiotic resistant colonies by antibiotic disc method / gradient plate method.
- Hanging drop method.
- Grams stain for different bacteria
- Negative staining technique of bacteria
- Determination of growth curve of bacteria
- Identification of fungal cultures
- Isolation of microorganism from soil
- Study of following disease
 1. Tikka disease of groundnut
 2. Black rot of crucifer
 3. Tundu disease of wheat
 4. Leaf curl of Tomato
 5. Root knot of Brinjal
 6. Ear cockle of wheat
 7. Mango necrosis

Suggested Readings:

1. Agrios, G.N. 2005. Plant Pathology, 5th edition. Academic Press, New York, USA.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4th edition, John Wiley and Sons, Inc., New York, USA.
3. Khan, J.A. and J. Dijkstra. 2002. Plant Virus as Molecular Pathogens. The Haworth Press Inc. USA.
4. Mehrotra, R.S. and A. Agarwal. 2003. Plant Pathology. 2nd Edition. TATA McGraw Hill. Pub. Company Ltd. New Delhi.
5. Singh, R.S. 1982. Plant Pathogens : The Fungi. Oxford and IBH Publishing Company, New Delhi, India.
6. Singh, R.S. 1989. Plant Pathogens : The Prokaryotes. Oxford and IBH Publ. Company, New Delhi, India.
7. Trigiano, R.N., M.T. Windham and A.S. Windham. 2008. Plant Pathology: Concepts and Laboratory Exercises. 2nd edition. CRC Press.
8. Vidhyasekaram, P. 2004. Concise Encyclopedia of Plant Pathology. Food product Press and Haworth Press INC. Binghamton, Ne

MBOT 204 Plant Physiology and Metabolism

Unit-I

Solute transport and photoassimilate translocation: uptake, transport and translocation of water, ions, solutes and macromolecules from soil through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

Biomolecules: General structure, classification properties, distribution and functions of primary metabolites (carbohydrates, proteins, amino acids, lipids) and secondary metabolites (flavonoids, alkaloids, steroids) and their role in plant defense mechanism. Conformations of Proteins (Ramachandran Plot, secondary structure, domains, motifs and folds, stabilizing interaction (van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction). (15hrs)

Unit-II

Photosynthesis: Photosynthetic pigments, absorption and transformation of radiant energy, (Light harvest complex LHC) photo-oxidation, red drop effect, Emerson enhancement effect, photosynthetic quantum yield, Photorespiration, CAM factors affecting photosynthesis, Bacterial photosynthesis.

Respiration: Bioenergetics, Glycolysis, Krebs cycles, Electron Transport System (ETS), Pentose phosphate pathway, Hexose monophosphate shunt, glyoxylate pathway, Glycogenesis, Gluconeogenesis, Respiratory inhibitors, High energy compounds, their synthesis and utilization. (15hrs)

Unit-III

Carbohydrate: Structure, classification: Monosaccharide, disaccharide and polysaccharide

N₂ metabolism: N₂ fixation symbiotic and asymbiotic, Nodule development, amino acid metabolism.

Fat metabolism: Synthesis of long chain fatty acids, lipid biosynthesis, and oxidation.

Enzymes –Principles of catalysis, enzymes and enzyme kinetics, regulation of enzyme activity, mechanism of action, isoenzyme.

Vitamins metabolisms: Structure and function (Thiamine, Riboflavin, Ascorbic acid, and Vitamin D)

(15hrs)

Unit-IV

Plant growth regulators (Natural and synthetic): Chemical nature, bioassay, physiological effects and mode of action of Auxins, Gibberelins, Cytokinines, Abscisic acid and Ethylene. Morphactins, Methylhydrazide. Strigolactones, Salicylic acid, Brassinosteroids.

Sensory photo biology: Structure, function and mechanism of action of phytochrome, cryptochrome and phototropins; Photoperiodism and Circadian rhythm. (15hrs)

Suggested Laboratory Exercises:

1. Effect of seed coat on water absorption by dry seeds
2. Effect of the nature of seed on water absorption.
3. Experimental demonstration of living nature of protoplasm and plasma membrane.
4. Measurement of leaf area by graph paper / by weighing method.
5. Determination of the rate of transpiration by simple method (conical flask method) and comparison of the rates of transpiration of two different leaves.
6. Determination of stomatal frequency, stomatal area, total number of stomata per leaf and transpiration index.
7. Determination of the effect of antitranspirant chemical on transpiration.
8. Determination of the effect of environmental condition on transpiration rates in plants.
9. Detection of essentiality of mineral elements by sand culture technique.
10. Demonstration of Hill reaction.
11. Effect of CO₂ concentration on photosynthesis.
12. Study of the effect of monochromatic light on photosynthesis.
13. Effect of temperature on photosynthesis.
14. Determination of RQ, by Ganong respirometer.
15. Measurement of vertical growth by aneauo.
16. Auxin bioassay
17. Separation of chlorophyll pigments by paper chromatograph.
18. Separation of chlorophyll pigments by solvent method.
19. Extraction of water soluble anthocyanin pigments and its characterization.
20. Demonstration of the temp. coefficient (Q₁₀) on physiological process.

21. To prepare standard curve of Sugar.
22. To prepare standard curve of Protein by Lowry method and estimate the protein content in unknown sample.
23. To prepare standard curve of Phenol.
24. Estimation of free titrable organic acids from plant materials.
25. Demonstrate the activity of different enzymes- Catalase, Peroxidase, Invertase and Dehydrogenase.
26. Verify Beers and Lambert law.
27. Detection of Alkaloids and Tannin.
28. To separate the amino acids by paper chromatography in the given mixture.
29. Qualitative estimation of Carbohydrates, Protein, Fats and Oils.

Suggested Readings:

- Hopkins, W.G. and Huner, P. A. 2008. Introduction to Plant Physiology. John Wiley and Sons, USA.
- Jain, V.K. 2013. Fundamental of Plant Physiology. S. Chand and Company Ltd., New Delhi.
- Malik, C. P. and Srivastava A.K. 1982. Text book of Plant Physiology. Kalyani publication, New Delhi.
- Mukherjee S., Ghosh A. K. 2006. Plant Physiology. New Central Book Agency, Calcutta.
- Parashar, A. N. and Bhatia, K. N. 1985. Plant Physiology. Trueman Book Company, New Delhi.
- Sinha, R. K. 2007. Modern Plant Physiology. 2nd Edition Tata McGraw, New Delhi.
- Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition, Sinauer Associates Inc. Publishers, Massachusetts, USA.
- Verma, S. K. and Verma, M. 2000. A Text book of Plant Physiology, Biochemistry and Biotechnology. S. Chand and co. Ltd., New Delhi.
- Verma, V. 2007. Text Book of Plant Physiology. ANE Books, India.
- Berg, J.M., Tymoczko, J.L., Stryer, L. 2006. Biochemistry. 6th Edition, W.H. Freeman and Company, New York.
- Buchanan, B., Gruissem, W. and Jones, R. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
- Conn, E.E., Stumpf, P.K. and Bruening, G. 2006. Outlines of Biochemistry. 4th Edition, John Wiley and Sons Inc. New Jersey, USA.
- Elliot, W.H. and Elliot, D.C. 2009. Biochemistry and Molecular Biology. Oxford Publishers, India.
- Nelson, D.L. and Cox, M.M. 2004. Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
- Ranjit, K. 2008. Research methodology: A step by step guide for beginners. Pearson, India.
- Sinha R. K., 2007. Modern Plant Physiology. 2nd Edition Tata McGraw, New Delhi.
- Voet, D. and Voet, J.G. 2000. Biochemistry, John Wiley, New York.
- Wilson, K. and Walker, J. 2008. Principles and techniques of Biochemistry and Molecular Biology, Cambridge University Press.

III SEMESTER

MBOT: 301 Molecular Biology

Unit-I

Genes and DNA: Evidence of DNA and RNA as the genetic material for bacteria, virus and eukaryotes. Double helical structure of DNA, DNA supercoiling, coding DNA, gene mutations, ORF, gene structure, Exons and Introns, Non-coding DNA and RNA.

DNA replication, damage and repair: Initiation, elongation and termination. Replicons – linear, circular and D-loops, DNA polymerase, helicase and other enzymes and proteins used in replication, coordinating synthesis of the leading and lagging strands, okazaki fragments, topoisomerase activity, causes of DNA damage and molecular mechanisms of repair- excision repair system in bacteria and eukaryotes, base excision, recombination repair systems and SOS. (15hrs)

Unit-II

Transcription, post transcriptional changes: mRNA structure, prokaryotic and eukaryotic RNA Polymerases, transcriptional factors, promoter sequences, binding sites for RNA Polymerase, transcription initiation, elongation and termination, attenuation and antitermination. Role of enhancers, repressors, mediators and silencers, transcription inhibitors. RNA splicing and processing- capping, polyadenylation, splicing, spliceosome, mRNA stability, group I introns and transesterification, ribozymes, RNA editing. (15hrs)

Unit-III

Translation: Structure of tRNA, ribosome. Genetic code. Translation-formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, aminoacylation of tRNA, aminoacyl-tRNA synthetase and termination in prokaryotes and eukaryotes, translational inhibitors. Co and post translational modification of proteins.

Gene regulation: Lac and Trp operons, cis and trans acting elements, eukaryotic transcription regulation: differential gene expression. Regulation of chromatin structure (Histone modification, DNA methylation. Epigenetic inheritance). Regulation of Transcription initiation (role of transcription factors, enhancers). (15hrs)

UNIT-IV

Post transcriptional regulation: gene silencing (RNA interference: effect of miRNA and siRNA). Epigenome and epigenetics.

DNA cloning and Characterization: Restriction and other enzymes, expression vectors, basic steps in gene cloning, genomic and c-DNA libraries, electrophoresis, blotting techniques (Southern, Northern and Western), gene sequencing methods (Sanger's method and Maxam Gilbert's method), nick translation, DNA fingerprinting, PCR, RT-PCR, DNA-microarrays, DNA-Protein interaction (DNA footprinting, yeast two hybrid system) & cluster analysis. (15hrs)

Suggested Laboratory Exercises:

Isolation of nuclei and identification of histones by SDS-PAGE.

Isolation of plant DNA and its quantitation by a spectrophotometric method

Isolation of DNA and preparation of cot curve

Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining

Isolation of RNA and quantitation by a spectrophotometric method.

Polymerase Chain Reaction

Southern blot analysis using a gene specific probe.

Immunological Techniques: Oncheterlony method. ELISA and western blotting.

Suggested Readings:

1. Lewis, B. 2001. Genes X. Oxford University Press. New York.
2. Alberts, B. Bray, D., Lewis, J., Raff, M. Roberts, K. and Watson, J. D. 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.
3. Wolfe, S. L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co. California. USA.
4. Rost, T. *et al.* 1998. Plant Biology. Wadsworth Publishing Co. California. USA.
5. Buchanan, B. B., Gruissem, W., and Jones, R. L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA

6. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, .and Darnell, J. 2000. Molecular Cell Biology (4th Edition). W. H. Freeman and Co. New York, USA.
7. Glick, B. R. and Thompson, J. E. 1993. Methods in Plnt Molecular Biology and Biotechnology. CRC Press. Boca Raton. Florida.
8. Glover, D. M. and Hames, B. D. (Eds.). DNA Cloning 1: A Practical Approach Core Techniques. 2nd Edition PAS IRI Press at Oxford University Press. Oxford.
9. Shaw, C. H. (Ed.) 1988. Plant Molecular Biology: A Practical Approach. IRL Press Oxford.
10. Albert, B., Bray, D., Lewis, J., Raff, M., Robert, K. and Watson, J.D. 1989. Molecular Biology of the Cell (2nd editions). Garland Publishing Inc. New York.
11. Malacinski, G. M. and Freifeider, D. 1998. Essentials of Molecular Biology (3rd edition). Jones and B. Artlet Publishers. Inc. Lomdon.

MBOT 302 Taxonomy of Angiosperms

Unit-I

Biosystemic studies: Population concept, methods of biosystematics, biosystematics categories – Ecads, Ecotypes, coenospecies, evolution and differentiation of species – various models.
International code of Botanical nomenclature: principles, rules and recommendations, Taxonomic concept: Hierarchy, species, genus, family and other categories. (15hrs)

Unit-II

Taxonomic literature: Flora, Monograph, Icones, Library, Manuals, Journals, Periodicals, Index.
Taxonomic tools and techniques: Herbarium preparation, maintenance, utility, important national, international and digital herbaria, serological, molecular technique, GIS and Mapping biodiversity. (15hrs)

Unit-III

Taxonomic evidences: Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry and Genome analysis.
Classification: Phenetic system; Phylogenetic systems– Cronquist, Dahlgren, Thorne and APG system with merits and demerits. (15hrs)

Unit-IV

Salient features of the groups: Polypetalae, Gamopetalae, Monochlamydae and Monocotyledons including their important families.
Phylogeny of Angiosperm: Ancestors of angiosperms, time and place of origin of Angiosperms, habit of Angiosperm, primitive living angiosperm, inter relationship among the major groups of Angiosperm. (15hrs)

Suggested Laboratory Exercises:

1. Description of a specimen from representative, locally available families. List of Locally Available Families. (1) Ranunculaceae, (2) Capparidaceae, (3) Portulacaceae, (4) Caryophyllaceae, (5) Malvaceae, (6) Tiliaceae, (7) Sterculiaceae, (8) Zygophyllaceae, (9) Rhamnaceae, (10) Sapindaceae, (11) Leguminosae, (12) Combretaceae, (13) Myrtaceae, (14) Cucurbitaceae, (15) Umbelliferae – Apiaceae, (16) Rubiaceae, (17) Asteraceae, (18) Primulaceae, (19) Plumbaginaceae, (20) Asclepiadaceae, (21) Convulvulaceae, (22) Solanaceae, (23) Boraginaceae, (24) Polemoniaceae, (25) Acanthaceae, (26) Pedaliaceae, (27) Martyniaceae, (28) Bignoniaceae, (29) Labiatae, (30) Nyctaginaceae, (31) Polygonaceae, (32) Chenopodiaceae, (33) Amaranthaceae, (34) Aizoaceae, (35) Molluginaceae, (36) Euphorbiaceae, (37) Comelinaceae and (38) Cyperaceae.
2. Description of a species based on various specimens to study intraspecific variation: a collective exercise.
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.
4. Location of key characters and use of keys at family level.
5. Field trips within and around the campus, compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
6. Training in using floras and herbaria for identification of specimens described in the class.
7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.

Suggested Readings:

1. Cole, A.J. Numerical Taxonomy, Academic Press, London.
2. Davis, P.H. and Hywood, V.H. 1973. Principles of Angiosperms Taxonomy, Robert E. Kreiger Pub. Co., New York.
3. Grant, V. 1971. Plant Specimen, Columbia University Press London.
4. Grant, W.E 1984. Plant Biosystematics, Academic Press, London.
5. Harrison, H.J. 1971. New Concepts in Flowering Plant Taxonomy. Rieman Educational Book Ltd. U.K.
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. Current Concepts in Plant Taxonomy. Academic Press, London.
8. Jones, A.D. and Wilbins, A.D. 1971. Variations and Adaptations in Plant Species. Hiemand & Co. New York.
9. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematic (2nd Edition). Mc.Graw-Hill Book Co., New York.
10. Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. Plant Systematic for 21st Century Portland Press Ltd., London.
11. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper & Row Pub., USA.

12. Singh, H. 1978. Embryology of Gymnosperms. Encyclopedia of Plant Anatomy X. Gebruder Borntraeger, Berlin.
13. Solbrig, O.T. and Solbrig, D.J. 1979. Population Biology and Evolution, Addison Wesley Publishing Co. Ind. USA.
14. Solbrig, O.T. 1970. Principles and Methods of Plant Biosystematics. The Macmillan Co. Collier-Macmillan Ltd., London.
15. Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd Edition) Edward Arnold Ltd. London.
16. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.
17. Woodland, D.W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey.

MBOT: 303
Morphology and Developmental anatomy of Angiosperm

Unit-I

Introduction: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradient, cell fate and cell lineage.

Seed germination & seedling growth: Metabolism of proteins and mobilization of reserves food and tropism. seedling growth. Hormonal control of seedling growth, gene expression, use of mutants in understanding seedling development. (15hrs)

Unit-II

Shoot development: SAM organization, cytological and molecular analysis of SAM, stem cell in plants, primary and secondary tissue differentiation, xylem and phloem, secretory ducts, laticifers, wood development in relation to environmental factors. (15hrs)

Unit-III

Leaf growth and differentiation: Inception, phyllotaxy, leaf forms (leaf meristems and other factors) differentiation of epidermis, stomata, trichomes, mesophyll, Kranz anatomy, leaf trace, leaf gap, transfer cells.

Flower development: Floral meristem, genetics of floral organ differentiation, homeotic mutants in *Arabidopsis* and *Antirrhinum*. (15hrs)

Unit-IV

Root development: RAM organization, vascular tissue differentiation, lateral roots, root hairs, root microbe interaction.

Seed coat development: external and internal morphology of seed, seed appendages, ontogeny of seed coat, mature structure, spermoderm patterns. (15hrs)

Suggested laboratory / field exercises

1. Study of living shoot apices by dissecting using plants such as *Tabernaemontana*, *Albizia*.
2. Study of cytohistological zonation in shoot apical meristem (SAM) in sectioned and double stained Permanent slide of slide of a suitable plant. Examination of shoot apices in monocotyledon in both T.S and L.S. to show the origin and arrangement of leaf primordia.
3. Study of alternate and distichous. Alternate and superposed, opposite and superposed, opposite and decussate leaf arrangement examination of rosette plants (*Launaea*, *Mollugo*, *Raphanus*, *Hyoscyamus* etc.) and induction of Bolting under natural condition as well as by GA treatment. Microscopic examination of vertical section of leaves such as *Eucalyptus*, *Ficus*, *Mango*, *Nerium*, *Maize*, *Grass*, and *Wheat* to understand the internal structure of leaf tissues and trichomes, glands etc. study the leaf anatomy C3 and C4 of plants.
4. Study of epidermal peel of leaves such as *Coccinia*, *Tradescantia* etc. to study the development and final structure of stomata and prepare stomatal index.
5. Study of types of stomata in plants belonging to different families.
6. Study of whole roots in monocots and dicots.
7. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivative. (use *Maize*, aerial root of banyan etc.)
8. Study of lateral root development.
9. Study of leguminous roots with different types of nodules.
10. Study of primary and secondary tissue differentiation in roots and shoots.
11. Study of seed coat types – *Pisum*, *Cucurbita*, *Wheat*.
12. Study of vascular tissues by clearing technique.

Suggested Reading:

1. Atwell, B.J. Kriedemann, P.F. and Jumbull, C.G.N. (eds.) 1999. *Plants in Action: adaptation in nature performance in cultivation*, MacMillan Education, Sydney
2. Bewley, J.D. Black, M. 1994 *Seeds: Psychology of development and Germination*, Plenum Press, New York
3. Burgess, J 1985, *An Introduction to plant cell development*. Cambridge Univ. Press
4. Fahn, A. 1982 *Plant Anatomy* (3rd edition) Pergamon Press, Oxford. New York
5. Raven, P.H., Evert, R.F. and Eichhorn, S. 1992 *Biology of Plants* (5th edition) Worth, New York
6. Salisbury P.B. and Ross C.W. 1992 *Plant Physiology* (4th edition) Wadsworth Publishing, California
7. Steeves, T.A. and Sussex I.M. 1989 *Patterns in Plant Development* (2nd edition) Cambridge Univ. Press
8. Waisel Y., Eshel, A. and Kafkaki, U. (eds.) 1996 *Plants Roots: The Hidden hall* (2nd edition) Marcel Dekker, New York

MBOT: 304 (A)
Advanced Plant Pathology I

Unit-I

Plant pathology: History and scope, nature and concept of plant disease, symptoms of plant disease. Host factor in disease development, host parasite interaction, transmission, inoculum potential, enzymes, effector and toxin in plant disease. Protective and defense mechanism (morphological, biochemical) in plants (15hrs)

Unit-II

Symptomology, Identification and control of following plant diseases:

Fungal disease:- white rust & early blight, Paddy blast,

Leaf rot and foot rot of pan (*Piper beetle*), Red rot of sugarcane, Flax rust.

Bacterial disease: Brown rot of potato, Blight of rice,

Crown Gall disease of stone fruits, Angular leaf spot of cotton. (15hrs)

Unit-III

Phytoplasma Disease: Little leaf of brinjal, Sesame Phyllody.

Plant Galls: Classification, developmental anatomy, host parasite interaction and physiology of insect induced plant galls of Rajasthan- *Pongamia*, *Cordia*, *Prosopis* and *Salvadora*, Economic significance of galls. (15hrs)

Unit-IV

Nematology: General account of nematodal diseases, symptoms, Methods used in Nematology. Control of plant parasitic nematodes. Inter relationship between nematodes and other plant pathogens.

Nematodes Disease: Molya disease of wheat and barley, Soyabean Cyst nematode. (15hrs)

Suggested laboratories exercises:

Histopathology of nematode infected roots

Study of following disease:

Red rot of sugarcane

Paddy blast

Flax rust

Crown gall disease of stone fruits

Angular leaf spot of cotton

Little leaf of brinjal

Sesame Phyllody

Galls of *Pongamia*, *Cordia*, *Prosopis*, *Salvadora*

Molya disease of wheat and barley

Soyabean cyst nematodes

Suggested Reading:

1. Agrios, G.N. 2005. Plant pathology, 5th edition Academic Press, New York, USA
2. Alexopoulos, C.J.C.W. Mims and M. Blackwell. 1996 Introductory Mycology, 4th edition, John Wiley and Sons, Inc., New York, USA
3. Khan, J.A. and Dijkstra. 2002. Plant virus as molecular pathogens. The Haworth Press Inc. USA
4. Mehrotra, R.S. and A. Agrawal. 2003 Plant Pathology. 2nd Edition TATA Mc Graw Hill. Pub. Company Ltd. New Delhi
5. Singh, R.S. 1982 Plant Pathogens: The Fungi. Oxford and IBH Publishing Company, New Delhi, India
6. Singh, R.S. 1982 Plant Pathogens: The Prokaryotes. Oxford and IBH Publishing Company, New Delhi, India
7. Triganio, R.N., M.T. Windham and A.S. Windham. 2008. Plant pathology: Concept and Laboratory Exercise. 2nd edition CRC Press.
8. Vidhyasekaram, P. 2004. Conise Encyclopedia of plant Pathology. Food product press and Haworth Press Inc. Binghamton, Ne.

MBOT 304 (B)
Seed Science and Technology-I

Unit-I

History of seed testing and its importance to agriculture, aims of seed testing, Seed definition & its types, Sampling of seeds, purity analysis (physical and genetical), seed moisture content, germination test, rapid test of viability and evaluation, seedling evaluation, various methods of seed separation, cleaning, drying and seed processing plant and its process. (15hrs)

Unit-II

Gross architecture of seed structure of angiosperms, identification and structure of seeds of important crop plants and with special reference to Rajasthan (wheat, pearl millet, mustard, gram pea, spices). Identification of designated objectionable weeds at seed level.

Principles of seed production, seed production in self and cross pollinated crops; hybrid seed production. Production of foundation and certified seeds, synthetic seed, terminator seed technology. (15hrs)

Unit-III

Physiology of seed germination; seed and seedling vigour, seed dormancy and longevity, seed storage methods, principles of safe seed storage, effects of storage, mycotoxins, Deterioration of seeds in storage by micro-organisms, insects and rodents, control of seed deterioration, seed bank. (15hrs)

Unit-IV

Seed certification standards and quarantine regulations. International cooperation, International Seed Testing Association (I.S.T.A.)- rules and recommendations, certificates, other seed certificates, Indian Seed Act and recent amendments, National and Regional seed Corporation of India- their organization, aims and functions. National and International co-operation in seed pathology. Sanitary and phytosanitary (SPS) agreement of WTO. (15hrs)

Suggested laboratory exercises:

1. Structure of seeds of some crop plants (wheat, pearl millet, mustard, gram, pea)
2. Common weed seeds in crop seed lots and their identification (Amaranthus and cynodon).
3. Study of purity of seed samples.
4. Study of seed germination, seedling abnormality and seedling index.
5. Determination of moisture content of seeds.
6. TZ test for seed viability.
7. Assays of enzymes in crop seeds.
8. Biochemical testing of starch, protein, lipids, tannins, phenols and lignins in seed sections.
9. Localization of starch, protein, lipids, tannins, phenols and lignins in seed sections.
10. Isolation and identification of storage fungi.
11. Preparation of phytosanitary certificate etc. of seed lot.

Suggested Readings:

1. Agarwal, V.K. and Sinclair, J.B. (1987). Principles of seed-pathology, II edition CRC Lewis Publishers, Boca Raton, New York, London.
2. Agarwal, R.L. 1980. Seed Technology, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
3. Anonymus (1985). International rules for seed testing. International Seed Testing Association (ISTA). Seed Sci. & Tech.
4. Bewley, J.D. and Black, M. 1983. Physiology and Biochemistry of seeds in relation to germination, Volume I & II, Springer-Verlag, Berlin, Heidelberg, New York.
5. Copeland, L.O. 1976 Principles of Seed Sci. and Technology Minnesota, USA.
6. Kulkarni, G.N. 2002. Principles of seed Technology, Kalyani Publishers, New Delhi.
7. Neergaard, P. 1986. Seed- A horse of hunger or a source of life. Revised print of Danish Government Institute of seed pathology for Developing Countries, Hellerup, Denmark.
8. Winton, A.L. and Winton, K.B. (1932-1939). The structure and Composition of foods Vol I and II, John Wiley and Sons, Inc., New York.

MBOT 304 (C)
Advanced Plant Physiology-I

Unit-I

Proteins and Enzymes: Techniques of protein purification, protein sequencing and proteomics, Enzyme kinetics, Michaelis Menten equation and significance of K_m value, negative and positive co-operativity, enzyme nomenclature and E.C. number, Catalytic mechanisms: Acid-Base catalysis, covalent catalysis, metal ion catalysis, electrostatic state bonding, Lysozyme as model enzyme for catalytic mechanism, Regulation of enzyme activity, feedback and allosteric regulation, active sites, coenzymes, activators and inhibitors. (15hrs)

Unit-II

Nucleotides metabolism: Biosynthesis of Ribonucleotides and of Deoxy-ribonucleotides-salvage and denovo pathways, nucleotide degradation.

Vitamins: Water and fat soluble vitamins, biochemical functions of thiamine, riboflavin nicotinic acid, pantothenic acid, pyridoxine, biotin, folic acid, vitamin B12, ascorbic acid, vitamin A and Vitamin D. (15hrs)

Unit-III

Secondary Metabolism: Coumarins and Lignins: structure and synthesis

Insecticides (pyrethrins and rotenoids): distribution, chemistry and function

Tannins: distribution, synthesis and function

Flavonoids and water soluble pigments: synthesis and function

Hallucinogens: distribution, chemistry and function (15hrs)

Unit-IV

Alkaloids: Pyrrole, Pyrrolidine, Pyridine, Polyacetylquinoline, Tropane and Indole alkaloids- distribution, synthesis and function.

Saponins and Sapogenins: Sterols, Steroids, Steroidal Alkaloids – distribution, synthesis and function.

Cardiac Glycosides: distribution, structure and synthesis (15hrs)

Suggested laboratory exercises:

1. Quantitative estimation of protein using Lowry's method
2. Isolation of casein from milk and its quantification
3. Quantitative estimation of Vit. C
4. Extraction and identification of flavonoids and alkaloids using TLC
5. Preliminary detection of Flavonoids, Alkaloids and steroids

Suggested Readings:

1. Lehninger, A.L., Nelson, D. L., Cox, M.M. Principles of Biochemistry. 3rd edition. Macmillon Publishers Worth New York. 2000.
2. Jain, J.L. Fundamental of Biochemistry. 2nd edition. Willey, New York.1995.
3. Voet, D. and Voet, J.G. Biochemisry 2nd edition. Willey, New York, 1995

IV SEMESTER

MBOT: 401 Embryology of Angiosperms

Unit-I

Reproduction: Vegetative options and sexual reproduction, anther structure, microsporogenesis, role of tapetum, pollen development and gene expression, male sterility, sperm dimorphism, hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos. Female gametophyte, ovule development, megasporogenesis, organization of the embryo sac, embryo sac cells structure. (15hrs)

Unit-II

Floral characteristics, Pollination mechanism and vectors, fertilization, pollen-pistil interaction, pollen stigma interaction, sporophytic and gametophytic self incompatibility (cytological, biochemical and molecular aspects), double fertilization, *in vitro* fertilization. (15hrs)

Unit-III

Seed development and fruit growth: Endosperm development, embryogenesis, cell lineages during late embryo development. Storage proteins of endosperm and embryo. Polyembryony, apomixis, embryo culture, dynamics of fruit growth, biochemistry & molecular biology of fruit maturation. (15hrs)

Unit-IV

Latent life, dormancy, types of dormancy, importance, seed dormancy, overcoming seed dormancy, bud dormancy. Senescence and programmed cell death, types of cell death, PCD in life cycle of plants, metabolic changes associated with senescence, influence of hormones, effect of environmental factors on senescence. (15hrs)

Suggested practical

1. Study of microsporogenesis and gametogenesis in section of anther of different ages.
2. Examination of mode of anther dehiscence and collection of pollen grains for microscopic examination (maize, grass, *Cannabis sativa*, *Crotalaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanum melongena*, etc.)
3. Study of wall layers of anther.
4. Test for pollen viability using stains and *in vitro* germination.
5. Pollen germination using hanging drop and sitting drop culture, suspension culture, and surface culture.
6. Estimating percentage and average pollen tube length *in vitro*.
7. Study of ovules in cleared preparation. Study of monosporic, bisporic and tetrasporic type of embryo sac development through examination of permanent stained serial section.
8. Field study of several types of flower with different pollination mechanisms.
9. Emasculation, bagging and hand pollination to study pollen germination.
10. Study of nuclear and cellular endosperm through dissection and staining.
11. Isolation of zygote globular heart shaped torpedo stage and mature embryo from suitable seeds.
12. Polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissection.
13. Biochemical estimation (qualitative and quantitative) of metabolites of seeds.

Suggested readings:

1. Atwell, B.J., Kriedemann, P.F. and Jumbull, C.G.N. (eds.) 1999 *Plants in Action: Adaptation in Nature Performance in cultivation*, MacMillan Education, Sydney
2. Bewley, J.D., Black, M. 1994 *Seeds: Physiology of development and Germination*, Plenum Press, New York
3. Bhojwani S.S. and Bhatnagar S.P. 2000 *The Embryology of Angiosperms* (4th revised and enlarged edition) Vikas Publishing House, New Delhi
4. Burgess, J. 1985, *An Introduction to plant cell development*. Cambridge Univ. Press
5. Fager K. and Van der Pijl L. 1979 *The Principle of Pollination Ecology*. Pergamon Press, Oxford
6. Fahn, A. 1982 *Plant Anatomy* (3rd edition) Pergamon Press, Oxford. New York
7. Fosker D.E. 1994. *Plant Growth and Development. A Molecular Approach*. Academic Press San Diego
8. Howell, S.H. 1998. *Plant Growth and Development. A Molecular Approach* Academic Press, San Diego.

9. Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Flora Development, J. Cramer, Germany.
10. Lyndon, R.F. 1990 Plant Development, The Cellular Basis, Unwin Hyman London
11. Murphy T.M. and Thompson W.E. 1988, Molecular Plant Development Prentice Hall, New Jersey
12. Proctor M. and Yeo. P. 1973 The Pollination Of Flowers. William Collins Sons, London
13. Raghavan V. 1997 Molecular Embryology of Flowering plants. Cambridge University Press Cambridge
14. Raghavan V. 1999 Developmental Biology Of Flowering Plants, Springer –Verlag, New York
15. Raven. P.H., Evert. R.I. and Eichhorn. S. 1992 Biology Of Plants (5th edition) Worth, New York
16. Salisbury P.B. and Ross C.W. 1992 Plant Physiology (4th edition) Wadsworth Publishing, California
17. Steeves, T.A. and Sussex I.M. 1989 Patterns in Plant Development (2nd edition) Cambridge Univ. Press, Cambridge
18. Sdgley, M. And Griffin, A.R. 1989 Sexual Reproduction to Tree Crops. Academic press, London
19. Shivanna K.R. and Sawhney VK, (eds) 1997 Pollen Biotechnology For Crop Production and Improvement, Cambridge University, Cambridge
20. Shivanna K.R. Rangaswamy, N.S. 1992 Pollen Biology : A Laboratory Manual Springer – Verlag, Berlin
21. Shivanna K.R. and Johri B.M. 1995, An Angiosperms Pollen : Structure And Function. Wiley Eastern Ltd. New York
22. The Plant Cell Special Issue On Reproductive Biology Of Plants Vol. 5 (10) 1993

MBOT 402
Plant Resource Utilization & Ethnobotany

Unit-I

Plant Biodiversity: Concept, status in India, utilization and concerns. Sustainable development: Basic Concepts. Origin of agriculture.
World centers of primary diversity of domesticated plants: The Indo-Burmese centre, plant introductions and secondary centers. (9hrs)

Unit-II

Origin, evolution, botany, cultivation and uses of: (i) Food, forage and fodder crops, (ii) ornamental plants, plants used in sericulture, as petro crops, in narcotics, as mastigatories, fumitories and fiber crops, (iii) medicinal and aromatic plants (iv) vegetables, fruits, spices condiments and oil yielding crops (v) Important fire-wood and timber-yielding plants and non-wood forest products (NWFPs) such as bamboos and rattans. Raw materials for paper making, gums, tannins, dyes and resins.

Green revolution: Benefits and adverse consequences. Plants used as avenue trees for shade, pollution control and aesthetics. (20hrs)

Unit-III

Principles of conservation: Extinctions, environmental status of plants based on International Union for Conservation of Nature (IUCN).

Strategies for conservation – in situ conservation: International efforts and Indian initiatives, protected areas in India-sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs, conservation of wild biodiversity.

Strategies for conservation – ex situ conservation: Principles and practices, botanical gardens. Field gene banks, Seed banks, *in vitro* repositories and cryobanks. (15hrs)

Unit-IV

General account of the activities of Botanical Survey of India (BSI), National Bureau of plant Genetic Resources (NBPGR), Indian Council of Agriculture Research (ICAR), Council of Scientific and Industrial Research (CSIR) and Department of Biotechnology (DBT) for conservation and non formal conservation efforts. (10hrs)

Ethnobotany: History, development and scope of ethnobotanical study, Interdisciplinary approaches, ethnic groups of India, Applied Ethnobotany: role of ethanobotany in national priorities, health care and development of cottage industries in India. (6hrs)

Suggested Laboratory Exercises

The practical course is divided into three units (1) Laboratory work, (2) Field survey and (3) Scientific visits

Laboratory Work

1. Food crops : Wheat, rice, maize, chickpea (Bengal gram), Potato, Sweet Potato, Sugarcane: Morphology, anatomy, Biochemical tests for stored food materials
2. Forage fodder crops: Study of any five important crops of the locally available (for example fodder, sorghum, Bajra, khejari Ardu, Zizyphus)
3. Plant fiber: Cotton, Jute, hemp, sunn hemp, Cannabis, Kapok: Morphology anatomy, microscopic study of whole fibre using appropriate staining procedure.
Medicinal and aromatic Plants: Depending on the geographical location; *Papaver somniferum*, *Catharanthus roseus*, *Adhatoda cylanica*, *Allium sativum*, *Rauwolfia serpentine*, *Withania somnifera*, *Phyllanthus amarus*, *P. fraternus*, *Andrographis panic ulata*, *Aloe Berbadadens*, *Mentha arvensis*, *Rosa spp.* *Pogostemon cablin*, *Origamom vulgare*, *Vetiveria zizinooides*.
4. Study of live or herbarium specimens or other visual materials to become familiar with these resources.
5. Vegetable oils: Mustard, groundnut, Soyabean, coconut, sunflower, castor.
Morphology, microscopic structure of the oil yielding tissues. test for oil and iodine number.
6. Gum, resins, tannins, dyes: perform simple test for gums and resins. prepare a water extract of vegetable tannins (*Acacia*, *terminalia*, *tea*, *cassia spp.*) and dyes (*Turmeric*, *Indigo*, *Butea*, *lawsonia*) and perform test to understand their chemical nature.
7. Firewood and timber yielding plants.

Field survey-

1. Prepare a short list of 10 most important sources of fire wood and timber in your locality. Give their local names, scientific names and families to which they belong. Mention their properties.
2. A survey of a part of the town or city should be carried out by the entire class to make the student aware about the vegetation characteristics of particular area in city or town.

Scientific visits

The students should be taken to one of the following:

1. A Protected area (Biosphere reserve, National park and Sanctuary)
2. A Wetland
3. Mangroove

Suggested Readings

1. Anonymous 1997. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
2. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.
3. Baker, H.G. 1978. Plants and Civilization (3rd edn.) C.A. Wadsworth, Belmont. 41.
4. Bole, P.V. and Vaghani, Y. 1986. Field Guide to Common Indian Trees. Oxford University Press, Mumbai.
5. Chandel, K.P.S., Shukla, G. and Sharma, N. 1996. Biodiversity in Medicinal and Aromatic plants in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
6. Chrispeels, M.J. and Sadava, D. 1977. Plants, Food and People, W.H. Freeman and Co., San Francisco.
7. Cristi, B.R. (ed.) 1999. CRC Handbook of Plant Sciences and Agriculture. Vol. I. In situ conservation. CRC Press, Boca Raton, Florida, USA.
8. Conway, G. 1999. The Doubly Green Revolution : Food for All in the 21st Century. Penguin Books.
9. Conway, G. and Barbier, E. 1990. After the Green Revolution. Earthscan Press, London.
10. Conway, G. and Barbier, E. 1994. Plant. Genes and Agriculture. Jones and Bartlett Publishers, Boston.
11. Council of Scientific and Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate, CSIR, New Delhi.
12. Council of Scientific and Industrial Research (1948-1976). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products. New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (200).
13. Cronquist, A. 1981. An Integrated System of Classification of Flowering plants. Columbia University Press, New York, USA.
14. Directory of Indian Wetlands, 1993. WWF INDIA, New Delhi and AWB, Kuala Lumpur.
15. Falk, D.A., Olwel, M. and Millan C. 1996. Restoring Diversity, Island Press, Columbia, USA.
16. FAO/IBPGR 1989. Technical Guidelines for the Safe Movement of Germplasm. FAO/IBPGR, Rome.
17. Frankel, O.H., Brown, A.H.D. and Burdon, J.J. 1995. The Conservation of Plant Diversity. Cambridge University Press, Cambridge, U.K.
18. Gadgil, M. and Guha, R. 1996. Ecology and Equity : Use and Abuse of Nature in Contemporary India. Penguin, New Delhi.
19. Gaston, K.J. (Ed.) Biodiversity : a Biology of Numbers and Differences. Blackwell Science Ltd., Oxford, U.K.
20. Heywood, V. (Ed.) 1995. Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press, Cambridge, U.K. 42.
21. Heywood, V.H. and Wyse Lackn, P.S. (Eds.) 1991. Tropical botanical Gardens. Their Role in Conservation and Development. Academic Press, San Diego.
22. Kocchar, S.L. 1998. Economic Botany of the Tropics, 2nd edition. Macmillian India Ltd., Delhi.
23. Kothari, A. 1997. Understanding Biodiversity : Life Sustainability and Equity. Orient Longman.
24. Kohli, R., Arya, K.S., Singh, P.H. and Dhillon, H.S. 1994. Tree Directory of Chandigarh, Lovdale Educational, New Delhi.
25. Nair, M.N.B. et al. (Eds.) 1988. Sustainable Management of Nonwood Forest Products. Faculty of Forestry, University Putra Malaysia. 43004 PM Serdang. Selangor, Malaysia.
26. Paroda, R.S. and Arora, R.K. (1991). Plant Genetic Resources Conservation and Management. IPGRI (Publication) South Asia Office, C/o NBPGR. Pusa Campus, New Delhi.
27. Pimentel, D. and Hall, C.W. (Eds.) 1989. Food and Natural Resources, Academic Press, London, New York.
28. Pinstrip-Anderson, P. et al. 1999. World Food Prospects : Critical Issues for the Early 21st Century. International Food Policy Research Institute. Washington D.C., USA.
29. Plant Wealth of India 1997. Special Issue of Proceedings Indian National Science Academy B-63.
30. Plucknett, D.L., Smith, N.J.H., William, J.T. and Murti Annishetty, N. 1987. Gene Banks and Worlds Food. Princeton University Press, Princeton, New Jersey, USA.
31. Rodgers, N.A. and Panwar, H.S. 1988. Planning a Wildlife Protected Area Network in India. Vol. I. The Report. Wildlife Institute of India, Dehradun.
32. Sahni, K.C. 2000. The Book of Indian Trees. 2nd edition. Oxford University Press, Mumbai.

33. Schery, R.W. 1972. *Plants for Man*. 2nd ed. Englewood Cliffs, New Jersey. Prentice Hall.
34. Sharma, O.P. 1996. *Hill's Economic Botany* (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
35. Swaminathan, M.S. and Kocchar, S.L. (Eds.) 1989. *Plants and Society*. Macmillan Publication Ltd., London.
36. Thakur, R.S., Puri, H.S. and Husain, A. 1989. *Major Medicinal Plants of India*. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.
37. Thuomas, P. 2000. *Trees: Their National History*. Cambridge University Press, Cambridge.
38. Wanger, H., Hikino, H. and Franswarth, N. 1989. *Economic and Medicinal Plant Research*. Vol. 1-3. Academic Press, London.
39. Walter, K.S. and Gillett, H.J. 1998. *1997 IUCN Red List of Threatened Plants*. IUCN, the World Conservation Union, IUCN, Gland, Switzerland and Cambridge, U.K.

MBOT 403
Plant Biotechnology and Genetic Engineering

UNIT-I

Plant tissue culture: Principles and concept, history, general methodology, culture media ingredients, preparation methods of sterilization and disinfections, aseptic techniques and preparation of explant, micropropagation in plants, shoot morphogenesis and organogenesis, callus and suspension cultures, microspore culture for producing haploids and their importance. Somatic embryogenesis: Principles, concepts and applications. Protoplast technology- isolation methods, purification, viability tests, culture, plating efficiency, somatic cell hybridization, selection of protoplast fusion hybrids, somaclonal variation, production of secondary metabolites. Overview of plant tissue culture applications. (15hrs)

UNIT-II

Metabolic Engineering and Industrial Products: Basic concept of metabolic engineering, strategies used in metabolic engineering, biotransformation, cell permeabilisation, elicitation hairy roots, media manipulation, manipulation of phenylpropanoids / Shikimic pathway, production of industrial enzymes, biodegradable plastics, biopolymers and antibiotics.

Vectors for plant transformation: Basic features of vectors (Promoters, terminators and sequences influencing gene expression, selectable markers & reporter gene, origin of replication. Co-integrative and binary vector for plant transformation), codon optimization. (15hrs)

UNIT-III

Techniques for plant transformation. Biology of *Agrobacterium*. *Agrobacterium* mediated gene transfer, process of T-DNA transfer and integration, practical applications of *Agrobacterium* mediated gene transfer. Application of DNA based molecular markers (RFLP, RAPD, AFLP) in plant biotechnology, genome editing, TALE, CRISPR. Heterologous gene expression in plants and genetic manipulation of plants for herbicide tolerance, insect resistance, Stress tolerance, disease resistance, improvement of crop yield and quality (Post harvest losses, longer shelf life of fruits and flowers, color manipulation of flower, making of golden rice). (15hrs)

UNIT-IV

Molecular farming for carbohydrates, lipids and proteins (Edible vaccines and Oleosin system). **Science and society:** Public acceptance of genetically modified crops (Public concerns, current status of transgenic crop, regulation of GM crops, Cisgenic crops and products). Introduction to Intellectual Property. Biosafety guidelines. Environmental release of GMO's. Risk analysis, Risk assessment, Risk management.

Introduction to bioinformatics: Definition, history, applications and scope. Biological databases and sequence analysis. BLAST and FASTA. Multiple sequence alignment, phylogenetic analysis and bioinformatics in drug discovery. Bioinformatics in India. (15hrs)

Suggested laboratory exercises:

1. Preparation of Media
2. Surface sterilization
3. Micropropagation Technique
4. Organ Culture
5. Callus Propagation, organogenesis and transfer of plants to soil
6. Anther Culture and Production of Haploids
7. Preparation of Synthetic seeds
8. Cytological examination of regenerated plants
9. Isolation of protoplasts from various plant tissues and testing their viability
10. PCR and Gel Electrophoresis
11. Techniques : Biolistics, Membrane Filtration and Cell Counting
12. Hairy root cultures
13. Extraction of alkaloids and flavonoids from plant materials and their separation using TLC.
14. BLAST
15. FASTA

Suggested readings:

1. J. Hammond, P. McGarvey. Plant Biotechnology. Springer Verlag. 2000.
2. H.S. Chawla. Biotechnology in Crop Improvement. International Book Distributing Company. 1998
3. R. J. Henry. Practical Application in Plant Molecular Biology. Chapman and Hall. 1997
4. P.K. Gupta. Plant Biotechnology. Rastogi and Co. Merrut. 2010.

5. Bhojwani, S.S. and Rajdan, M. K. 1996. Plant Tissue Culture. Theory and Practice (A Revised edition). Elsevier Science Publication, New York, USA.
6. Metabolic Engineering. Stephenopoulos, Arisitidou, A.A. and Neilson, J. Academic Press
7. Bioprocess Engineering. Shuler, M. I. and Kargi, F. PHI private Learning Ltd., New Delhi..
8. Basic Biotechnology. Ratledge, C. ,Kristainsen, B. Cambridge Publication.

MBOT 404 (A)
Advanced Plant Pathology-II

Unit-I

Plant disease epidemiology and plant disease forecasting: Computer simulation of epidemics, methods used in plant forecast, examples of plant disease forecasting system. (5hrs)

Unit-II

Disease management: Principles and economics, regulatory methods, cultural practices and physical methods, chemical treatment, biological control, host resistance and production of resistance varieties, integrated approach and future prospects, responses of traditional and nontraditional plant growth regulators to plant disease and management. (20hrs)

Unit-III

Breeding for disease resistance: General account and production of disease resistant plant. Integrated pest management Host pathogen specificity and responses. (17hrs)

Unit-IV

Molecular plant pathology: Molecular diagnosis, identification of genes and specific molecules in disease development, genetics of host pathogen interaction, molecular mechanism of resistance. Application of biotechnology and information technology in plant pathology. (18hrs)

Suggested laboratory exercises-

1. Biochemistry- alternated plant physiology due to plant pathogen interaction.
2. Biochemistry of altered metabolites- protein, lipids, starch, cellulose peroxidases and poly phenol oxidase.
3. Virus detection through biological (indicator hosts and hosts range) and serological methods (elisa. Immunodiffusion) Virus indexing
4. Methods of application of fungicides- seed and foliar application
5. Bio-control of plant pathogen- dual culture technique.
6. Bioassay of fungicides poison food technique. Inhibition zone technique and slide germination technique.

Suggested Reading :

1. Agrios. G.N. 2005. Plant Pathology, 5th edition. Academic Press, New York. USA
2. Alexopoulos, C.J.C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4th edition. John Wiley and sons. Inc. New York. USA.
3. Khan J.A. and J. Dijkstra 2002 Plant Virus as Molecular Pathogens. The Haworth Press Inc. USA
4. Mehrotra, R.S. and A. Agrawal 2003 Plant Pathology 2nd Edition Tata McGraw hill Pub. Company Ltd. New Delhi
5. Singh R.S. 1982 Plant Pathogens : The Fungi Oxford and IBH Publ. Company New Delhi
6. Singh R.S. 1982 Plant Pathogens : The prokaryotes Oxford and IBH Publ. Company New Delhi
7. Trigiano R.N. ... M.T. Windham and A.S. Windham 2008 Plant pathology: Concepts and Laboratory Exercises. 2nd Edition C.R.C Press
8. Vidhyasekaran, P. 2004 Concise Encyclopedia Of Plant Pathology .Food Product Press. Bingham

MBOT 404 (B)
Seed Science and Technology-II

Unit-I

Introduction and importance of seed pathology in modern agriculture, History of Seed Pathology, Various methods for testing seed borne fungi, bacteria and viruses (Dry seed examination, seed washing test, incubation methods, cultural, biochemical, serological, nucleic acid based methods). (11hrs)

Unit-II

Mechanism of seed infection and its types, environment influencing seed infection, infected/contaminated part of seed, morphology and anatomy of seeds in relation to invasion, location of inoculum of the pathogen in seed-coat and pericarp, endosperm, perisperm and embryo. (12hrs)

Unit-III

Seed borne diseases of some important crops with particular reference to the state of Rajasthan and India. Typical case of infection by: fungi (Wheat- smut and bunts, sesame-charcoal rot); bacteria (Brassicac- black rot, cluster bean-bacterial blight); viruses (tomato mosaic virus, pea seed borne mosaic virus) and nematodes (Wheat-ear cockle, rice-white tip). (15hrs)

Unit-IV

Transmission of seed borne disease: systemic and non-systemic seed transmission, types of disease transmission, mode of establishment and course of disease from seed to seedling and plant, factors affecting seed transmission. (11hrs)

Management of seed-borne disease, principles of control, seed treatments (Physical, Chemical and Biological), mechanism of action of seed treatments, major seed treatments for important seed borne pathogens and their methods of application. (11hrs)

List of suggested practical exercises:

1. Dry seed examination of seed lots.
2. Isolation and identification of seed borne mycoflora by standard blotter method.
3. Preparation of culture media (PDA and NA).
4. Plating seeds on PDA/NA for identification of seed borne fungi and bacteria.
5. Other methods of plating eg. Deep freezing, 2, 4-D blotter method.
6. Water agar test tube seedling symptom test.
7. Study of any seed borne nematode disease.
8. Detection of bacterial and viral pathogens in seeds.
9. LOPAT test for detection of seed borne bacteria.
10. Nucleic acid based detection of seed borne pathogens.
11. Histopathology of infected seed samples.
12. Physical control of seed-borne pathogens.
13. Antibiotic/fungicidal assay against seed-borne pathogens.
14. Biological control of seed borne pathogens.
15. Field visits: Crop fields, FCI, NSC, Seed Testing Labs, Quarantine station, (eg. NBPGR) etc.

Suggested readings:

1. Agarwal, P. C., Mortensen, C. N. And Mathur, S.B. 1989. Seed borne diseases and seed health testing of rice. Technical Bull. No. 3. Danish government institute of seed pathology for developing countries (DGISP), Copenhagen and CAB International Mycological Institute, (CMI) UK.
2. Agarwal, V. K. 2006. Seed Health. International Book Distributing Company. Charbagh, Lucknow, India.
3. Agarwal, V. K. and Sinclair, J. B. 1987. Principles of seed pathology. II edition CRC Lewi Publishers, Boca Raton, New York, London.
4. Agarwal, R. L. 1980. Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi
5. Agrios, G. N. 2005. Plant Pathology. Academic Press, London, New York.
6. Cliffton, A. 1958. Introduction to the bacteria. McGraw Hill Book Co. New York.
7. Anonymous (1985, 2014). International rules for seed testing. International Seed Testing Association ISTA..
8. Khare, D. and Bhale, M.S. 2014. Seed Technology. Scientific Publishers (India), Jodhpur. Revised 2nd Ed.
9. Mandahar, C. L. 1978. Introduction to plant viruses. S. Chand & Co. Ltd., Delhi.

10. Mathur, S. B. and Cunfer, B. M. 1993. Seed borne diseases and seed health testing of wheat. Danish Government Institute of Seed Pathology for developing countries. Hellerup, Denmark.
11. Neergard, P. 1977. Seed Pathology. Vol. I & II. The Mac Millan Press Ltd. London.
12. Rangaswamy, G. & Mahadevan, A. 1999. Diseases of crop plants in India (4th edition). Prentice Hill of India, Pvt. New Delhi.
13. Richardson, M. J. 1990. An annotated list of seed borne diseases 4th edition. Proc. Int. Seed Test Assoc. Zurich, Switzerland.
14. Schaad, N. W. 1980. Laboratory guide for identification of Plant Pathogenic bacteria (edt.). Bacteriology committee of American Phytopathological Society), St. Paul, Minnesota.
15. Schaad, N. W. 1988. Laboratory guide for identification of Plant Pathogenic bacteria (2nd eds.). APS Press (The American Phytopathological Society), St. Paul, Minnesota.
16. Singh, D. and Mathur, S. B. 2004. Histopathology of seed borne infections. CRC Press, Boca Raton, London, New York, Washington DC. pp296.
17. Singh, K. G. and Manalo, P. L. 1986. Plant quarantine and Phytosanitary Barriers in the Asean. Asean Plant Quarantine Centre and Training Institute, Malays

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Advanced Plant Physiology-II

Unit-I

Signal transduction in plants: Receptors and G-Proteins, phospholipid signalling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity of protein kinases and phosphatase, signal transduction mechanism with special reference to Actin-cytoskeleton signal transduction, sugar induced signal transduction. (15hrs)

Unit-II

Stress physiology: Types of stress and physiological consequences, Response and resistance mechanisms, Molecular mechanism of tolerance, Stress tolerant Transgenics. Heat stress and heat shock proteins, Osmotic adjustments, Reactive oxygen species and oxidative stress, Metal toxicity. Biotic stress and response, HR and SAR mechanisms.

Photobiology: Photoreceptors, Phytochrome: History, discovery, physiological properties, interaction between hormones and phytochromes, role of different phytochromes in plant development and flowering. Cryptochromes and Phototropins. (15hrs)

Unit-III

Physiology of Flowering: Photoperiodism and vernalization. Biological clock. Physiology of seed dormancy, senescence and abscissions.

Circadian rhythms in plants: Nature of oscillator, rhythmic outputs, entertainments (inputs) and adaptive significance. (15hrs)

Unit-IV

Tools and Techniques: Principles and application of Spectrophotometry, principle of chromatography: Partition chromatography, Thin layer chromatography, column chromatography-ion exchange chromatography, gas liquid chromatography, high performance liquid chromatography, gel filtration, electrophoresis, ultra centrifugation (velocity and density gradient), ELISA and RIA. (15hrs)

Suggested labortray exercises:

1. Study of effect of PEG induced stress on seed germination
2. Effect of Red and Infra red light on seed germination and study of photomorphogenesis
3. Hormonal regulation of leaves and petal senescence
4. To study the rhythmic movements in plants
5. Study of changes in protein and starch content during seed development
6. Separation techniques: Spectropotmetry, chromatography, electrophoresis, ultracentrifugation ,ELISA

Suggested Readings:

1. Kumar, A. and Purohit, S. S. 1996. Plant physiology: Fundamentals and applications. Agrobotanical Publishers, Jodhpur.
2. Pandey, S.N. and Sinha, B. K. 1995. Plant Physiology. Vikas Publishing House, New Delhi.
3. Steward, F. C. 1959. Plant Physiology. Vol. 2, Academic Press, New York.