DEPARTMENT OF BOTANY

NEHRU GRAM BHARTI
(Deemed to be University)
M.Sc. Syllabus (Choice Based Credit System)
(To be implemented from the Academic Year 2021-22)
Preamble

Studies in plant sciences (Botany) reflect our desire to understand the nature of plant life and their evolution besides developing means of their applications. In recent decades, the study of genome sequencing of diverse species has been a primary driving force behind the expansion of our knowledge. As such, the approach in preparing the present syllabus has been to incorporate the outcome of the latest researches in addition to the classical theories. Following are the salient features:

- Studying the form and function of various plant groups from classical to current understanding
- Exploring the basic unit of life, the cell, from Robert Hooke to present – from cytology to cell biology and onwards
- Understanding the concept and the physical basis of genes and their evolution – from Mendel to modern; their functional, recombinational and mutational roles; their horizontal transfer through biotechnological means; and the latest upcoming fields of genomics, proteomics and transcriptomics, etc.
- Having a comprehensive view of the interaction between plants and their environment; study of various ecosystems; understanding the magnitude of human interference and alteration in our commonly shared biosphere with resource depletion, pollution and climate change.
- Knowing the diverse applications of plants in providing staple foods, materials such as timber, oil, rubber, fibres and drugs; in modern horticulture, agriculture and forestry, plant propagation, breeding and genetic modification; in the synthesis of chemicals and raw materials for construction and energy production.
- The opportunities of 'Skill Development' in each semester is proposed to enrich students in specialised fields as a support

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The syllabus of M. Sc. Botany based on **Choice Based Credit System** pattern comprises of **Four Semesters**. The examination in **1st, 2nd and 3rdsemesters** shall consist of 03 core theory papers, each with 03 credits (3x3= 9 credits); elective paper of 03 credits each (3x1=3 credits); one Practical of 03 credits (3x1=3 credits); one skill development based paper of 02 credits (2x1= 2 credits); and one Interdisciplinary based paper of 03 credits (3X1=3). The **4th semester** consists of 2 core papers for 03 and 03 credits and one elective papers of 03 credits each (3x1=3 credits); one Dissertation paper with 04 credit (4x1= 4 credits). Thus, each semester offers 20 credits (4x20=80 credits).
Each 03 credit theory paper is equivalent to 75 marks and the practical course consists of modules from the three core papers. The Examination in each theory paper and practical course shall be of three hours duration.

Following is the tabular summary of the four semesters followed by detailed syllabus of each course:

1st SEMESTER

Paper	Code	Paper Title	Credit	Lectures	Maximum Marks		
					Internal Assessment	End Semester Exam	Total
Paper I*(Core)*	**BOT 101**	**Phycology & Bryology**	**03**	**54**	**30**	**45**	**75**
Paper II*(Core)*	**BOT 102**	**Mycology & Microbiology**	**03**	**54**	**30**	**45**	**75**
Paper III*(Core)*	**BOT 103**	**Pteridology &Gymnosperms**	**03**	**54**	**30**	**45**	**75**
Paper IV (*Elective*)	**BOT 104 E1** **BOT 104 E2** **BOT 104 E3**	**Palaeobotany** or **Plant Pathology** or **Applied Phycology**	**03**	**54**	**30**	**45**	**75**
(*Practical*)	**BOT 105**	**Based on BOT 101, BOT 102 & BOT 103**	**03**	**54**	**30**	**45**	**75**
Paper V (*Skill Development*)	**BOT 106**	**Applied Microbiology**	**02**	**36**	**20**	**30**	**50**
Paper VI (*Interdisciplinary*)	**BOT 107**	**Bio-fertilizer**	**03**	**54**	**30**	**45**	**75**
		Total	**20**				**500**

2nd SEMESTER

Paper	Code	Paper Title	Credit	Lectures	Maximum Marks		
					Internal Assessment	End Semester Exam	Total
Paper I *(Core)*	**BOT 201**	**Angiosperms-Morphology, Taxonomy, Anatomy & Embryology**	**03**	**54**	**30**	**45**	**75**
Paper II*(Core)*	**BOT**	**Plant Physiology &**	**03**	**54**	**30**	**45**	**75**

	202	**Biochemistry**					
Paper III(*Core)*	**BOT 203**	**Cell & Molecular Biology**	**03**	**54**	**30**	**45**	**75**
Paper IV (*Elective*)	**BOT 204 E1** **BOT 204 E2** **BOT 204 E3**	**Pollination Biology** or **Photobiology of Cyanobacteria** or **Floristic Diversity**	**03**	**54**	**30**	**45**	**75**
(*Practical*)	**BOT 205**	**Based on BOT 201, BOT 202 & BOT 203**	**03**	**54**	**30**	**45**	**75**
Paper V (*Skill Development*)	**BOT 206**	**Food Processing**	**02**	**36**	**20**	**30**	**50**
Paper VI (*Interdisciplinary*)	**BOT 207**	**Statistical Methods**	**03**	**54**	**30**	**45**	**75**
		Total	**20**				**500**

3rd SEMESTER

Paper	**Code**	**Paper Title**	**Credit**	**Lectures**	**Maximum Marks**		
					Internal Assessment	**End Semester Exam**	**Total**
Paper I*(Core)*	**BOT 301**	**Morphogenesis, Tissue culture & Developmental Botany**	**03**	**54**	**30**	**45**	**75**
Paper II*(Core)*	**BOT 302**	**Genetics, Plant Breeding & Organic Evolution**	**03**	**54**	**30**	**45**	**75**
Paper III*(Core)*	**BOT 303**	**Plant Ecology & Environment**	**03**	**54**	**30**	**45**	**75**
Paper IV (*Elective*)	**BOT 304 E1** **BOT 304 E2**	**Environmental Quality Assessment** Or **Vegetative Propagation** or **Instrumentation**	**03**	**54**	**30**	**45**	**75**

	BOT 304 E3						
(*Practical*)	**BOT 305**	**Based on BOT 301, BOT 302 & BOT 303**	**03**	**54**	**30**	**45**	**75**
Paper V (*Skill Development*)	**BOT 306**	**Pomology**	**02**	**36**	**20**	**30**	**50**
Paper VI (*Interdisciplinary*)	**BOT 307**	**Forestry**	**03**	**54**	**30**	**45**	**75**
		Total	**20**				**500**

4th SEMESTER

Paper	**Code**	**Paper Title**	**Credit**	**Lectures**	**Maximum Marks**		
					Internal Assessment	**End Semester Exam**	**Total**
Paper I*(Core)*	**BOT 401**	**Plant diversification & Resource Utilization**	**03**	**54**	**30**	**45**	**75**
Paper II*(Core)*	**BOT 402**	**Biotechnology & Genetic Engineering**	**03**	**54**	**30**	**45**	**75**
Paper III	**BOT 403**	**Dissertation**	**04**				**100**
Paper IV (*Elective*)	**BOT 404 E1** **BOT 404 E2** **BOT 404 E3**	**Plant Protection** or **Bioinformatics** or **Bioenergy**	**03**	**54**	**30**	**45**	**75**
(*Practical*)	**BOT 405**	**Based on BOT 401 & BOT 402**	**02**	**36**	**20**	**30**	**50**
Paper V (*Skill Development*)	**BOT 406**	**Bioprocess Engineering**	**02**	**36**	**20**	**30**	**50**
Paper VI (*Interdisciplinary*)	**BOT 407**	**Herbal Medicine**	**03**	**54**	**30**	**45**	**75**
		Total	**20**				**500**

1st SEMESTER
BOT 101: PHYCOLOGY & BRYOLOGY

Unit I

Introduction to Phycology, Principles and systems of classification of algae, Comparative account of algal pigments, food reserves, cell wall, flagellation, chloroplasts and eye-spots, their phylogenetic and taxonomic importance

Unit II

Cell structure and thallus organization, heterocyst and akinete development and their role; chromatic adaptations and reproduction in Cyanophyta, distribution and ecology of cyanobacteria

Unit III

Range of thalli and methods of reproduction in Chlorophyta, evolutionary tendencies in Chlorophyta.A brief account of Bacillariophyta, Pyrrophyta, Haplophyta, Crysophyta, Xanthophyta, Euglenophyta and Prochlorophyta, and other related and recent new groups.Thallus organization and reproduction in Phaeophyta and Rhodophyta

Unit IV

General introduction including broad outline of classification and evolutionary trends.Bryogeographical regions in India, general features and adaptation to land habit.Origin and evolution of gamatophyte and sporophyte generations.Endemism and endemic liverwort genera of India. Bryophyte ecology, Moss protonema, protonemal differentiation and bud induction. Regeneration in bryophytes. Economic uses, chemistry of bryophytes, fossil bryophytes. Hepaticopsida / Marchantiophyta: distribution: Global and Indian. General characteristics, morphology, anatomy and life history of Marchantiales: *Plagiochasma*, *Asterella*, *Cryptomitrium*, *Targionia, Cyathodium*; Monocleales: *Monoclea*Sphaerocarpales: *Sphaerocarpus*, *Riella*; Calobryales: *Calobryum, Haplomitrium*; Metzgeriales: *Riccardia, Metzgeria*, *Pallavicinia*; Jungermanniales: *Radula*, *Herberta, Porella, Frullania,* etc.; Treubiales: *Apotreubia*

Unit V

Anthocerotophyta: distribution: Global and Indian, general features, Morphology, anatomy and life history of Anthocerotales: *Anthoceros, Notothylas*etc. Bryopsida/Musci: distribution: Global and Indian, general features, morphology and anatomy, life history of Sphagnales: *Sphagnum*, Andreaeales: *Andreaea*, Andreaeobryales: *Takakia*, Polytrichales: *Polytrichum, Pogonatum*; Tetraphidales: *Tetraphis (Georgia)*, Buxbaumiales: *Buxbaumia,* Bryales: *Bryum, Rhodobryum, Funaria*, etc.Peristome teeth in Mosses.

Suggested readings:

1. Kerr, S. R. and L. M. Dickie (2001). The biomass spectrum: a predator-prey theory of aquatic production. New York, Columbia University Press. 2. Smol, J. P. (2002). Pollution of lakes and rivers: a paleoenvironmental perspective. London, Arnold.
3. North American Lake Management Society and the Terrene Institute.(2001). Managing lakes and reservoirs. Madison, WI

4. Lehmkuhl, D. M. 1979. How to know the aquatic insects. Dubuque, Iowa, W.C. Brown Co.

5. Dillard, G. E. (1999). Common freshwater algae of the United States. Berlin, Gebr. Borntraeger Lee, Robert Edeward, 2008, Phycology, Fourth edition, Cambridge University Press

6. Graham Robin South and Alan Whittick, 1998, Introduction to Phyclogy, Blackwell Scientific Publication

7. Bold, H.C. and Wynne, M.J., 1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.

8. Dixon, R. , Biology of Rhodophyta, Koelt Science Publisher, West Germany

9. Fritsch, F.E., Structure and Reproduction of Algae, Vol. I & II, Cambridge University Press, Cambridge

10. Gangulee, H.C. and Kar, A.K., 2011, College Botany Vol. II (Algae+Fungi+Brophyta+Pteridophyta) , New Central Book Agency, Kolkata

11. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae+Fungi+Brophyta+Pteridophyta) , Pub. Rastogi Publication, Meerut
12. Parihar N. S. 1965, An Introduction to Embyophyta- Bryophyta. Central Book Depot. Allahabad.
13. Kashyap S. R. 1972, Liverworts of the Western Himalayas & the Punjab Plains. Part 1 & 2.
14. Richardson D. H. S, The Biology of Mosses.
15.Janice. M. Glime, 2006, Bryophyte Ecology.
16. Goffinet B. & Shaw. A. J. 2008, Bryophyte Biology.

BOT 102: MYCOLOGY & MICROBIOLOGY

Unit I

Introduction, General characteristics, scope and general principles of classification of fungi, molecular methods of fungal taxonomy, reproduction in fungi, heterothallism, parasexual cycle and sex hormones in fungi. General characteristics and importance of Plasmodiophora, dietyosteliomycota, acrasiomycota and myxomycota.General characteristics, classification and brief introduction of –Mastigomycotina-Chytridiomycetes, Hypochytridiomycetes and Oomycetes, Zygomycotina.

Unit II

Ascomycotina- General characteristics and brief introduction of Taphrinales, Schizosaccharomycetales, Saccharomycetales, Eurotiales, Hypocerales, Melanosporales, Phyllachorales, Ophiostomatales, Dioporthales, XylarialesSordariales, Meliolales, Rhytismales, Helotiales, Pezizales, Dothidiales, Pleosporales and Erysiphales with special reference to evolutionary tendencies in asexual and sexual reproduction. Basidiomycotina- General characteristics of Agaricales, Lycoperdales, Sclerodermatales, Phallales, Nidulariales, Aphyllophorales, Uredinales, Ustilaginales, Auriculariales and Tremellales, Deuteromycotina- Sphaeropsidales, Melanconiales, Moniliales and Mycelia sterilia.

Unit III

Introduction to microbiology, history and scope of microbiology, tools and techniques used in microbiology laboratory, Microbial evolution, Systematics and taxonomy of microorganisms.Primitive organisms, their metabolic strategies and molecular coding.Microbes of the extreme environment and their metabolic strategies. The microbial cell: general organization of cell and cell wall of prokaryotes, eukaryotes and Archaea, prokaryotic and eukaryotic cell structure andfunction

Unit IV

Introduction and general characteristics of Viruses, bacteriophages, Plant Viruses–their morphology, taxonomy, reproduction and transmission, Viruses of algae, fungi and insects. General account of Mycoplasma Lichens: Thallus structure, reproduction and economic importance

Unit V

Microbial nutrition, microbial growth, Gram negative and Gram positive bacteria, Archaebacteria, actinomycetes, Quorum sensing in Bacteria: gram negative bacteria: LUXI LUXR-Type: gram positive bacteria: peptide mediated quorum sensing, genetics, bacterial recombination and plasmids, Bacterial conjugation, DNA transformation, Transduction

Suggested readings:

1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganiss.13th edition, Pearson Education Inc.

2. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan.

3. Atlas, RM. 1995. Principles of Microbiology.Mobsy.

4. Lim, DV. 2003. Microbiology. Kendall/Hunt.

5. Boundless.2013. Microbiology. Boundless Learning, Incorporated.

6. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology.Lippincott Williams & Wilkins.

7. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition.McGraw-Hill.

8. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology.8th edition, McGraw-Hill.9. Webster, John, 1980, Introduction to Fungi, Cambridge University Press

10. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996, Introductory Mycology, Wiley

11.Carlile, M.J., Watkinson S.C. and Booday, G.W. , 2001, The Fungi, Academic Press

12. Deacon, J.W., Blackwell, M, 1997, Introduction to Modern Mycology, Oxford

13. Webster, John and Roland, W.S., 2007, Introduction to Fungi, Cambridge University Press

BOT 103: PTERIDOLOGY & GYMNOSPERMS

Unit I

General Introduction of pteridophytes, their peculiar features and similarities and dissimilarities with bryophytes and gymnosperms, pteridophytes classification based on molecular data by Smith et al. 2006. World distribution of pteridphytes with special references to India, Endangered pteridophytes their conservation.

Unit II

Origin and Evolution of pteridophytes, Gametophytes of pteridophytes, ecology of pteridophytes.Stomatal structures in pteridophytes, Spores of pteridophytes.Apogamy, Apospory and parthenogenesis.Sex organs and embryogeny in Pteridphytes.Ecology of pteridophytes, Economic importance of the pteridophytes, Cytogenetics of pteridophytes.

Unit III

Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: Early land plant and their evolutionary significance, Psilopsida, Lycopsida, Sphenopsida, Filicopsida. Coenopteridales, Ophioglosales, Marattiales, Osmundales and filicales;; Monographic study of *Isoetes, Psilotum, Ophioglossum, Osmunda, Lygodium, Cyathea, Gleichenia, Adiantum, Pteris, Christella*and aquatic ferns.

Unit IV

General introduction of gymnosperms with special reference to its salient features, similarities and dissimilarities with other groups like pteridophytes and angiosperms.Classifications of gymnosperms.Origin and Evolution of gymnosperms.Devonien pre ovules and origin of seed.Comparative morphology, anatomy, reproductive biology and phylogenetic studies of the following groups: Pteridospermopsida-Lyginopteridales, Medullosales, Callistophytales, Glossopteridales, PeltaspermalesCorystospermales and Caytoniales. Cycadopsida, Pentoxylopsida, Bennettiopsida, GinkgopsidaConiferopsida and Gnetopsida.

Unit V

Global distribution of gymnosperms with special reference to Indian plants.Endangered gymnosperms, their conservation and present status.Cytogenetics of Gymnosperms; Economic importance and biotechnology of gymnosperms

Suggested readings:

1. Rashid, A, 2011, An Introduction to Pteridopyta, 2nd edition, (Reprint), Pub. Vikas Publishing House Pvt. Ltd., Noida.
2 Gifford, Ernest, M., Foster, Adriance.S., 1989, Morphology and Evolution of vascular plant. W. H. Freeman; Third Edition.
3. Ogura, Yuzuru., 1972, Comparative Anatomy of Vegetative Organs of The Pteridophytes. Gebr.Borntraeger; 2nd edition.
4. Rashid, A.1999, An Introduction to Pteridophta: Diversity,Development,Differentiation. Vikas Publishing House Pvt Ltd.
5. Parihar, Narayan Singh., 1977, The Biology and Morphology of The Pteridophyte. Central Book Depot.
6. Eames, A.J. (1936) Morphology of Vascular plant-lower group. Tata McGraw Hill, New Delhi.
7. Chamberlain, Charles Joseph, b.(1863), Gymnosperm; Structure and Evolution. Chicago, III., The University of Chicago Press
8. ChhayaBiswas and B.M.Johri.The Gymnosperm. Springer; 1997, edition (16 April 2014)
9. Bhatnagar, S.P. Moitra, Alok. (1996). Gymnosperms.New Age International.
10. Pant DD. (2002), An Introduction to Gymnosperms, Cycas, and Cycadales, BirbalSahni Institute of Palaeobotany.

BOT 104 E1: PALAEOBOTANY

Unit I

Basic geological information – structure of Earth Types of rocks, stratigraphy, basic concepts of continental drift and plate tectonics; Dating the past, Geological time scale.. Fossilization process, Types of fossils; techniques to study fossils, reconstruction and nomenclature of fossil--- concepts of Parataxa and Eutaxa, objectives of palaeobotany

Unit II

Prebiotic Environment, chemical evoluation and origin of life, Pre-Cambrian life; Indian Pre-cambrain stratigraphy and life forms; Diversification of algae, fungi and bryophytes through the ages; Origin and evolution of land plants, earliest records of pteridophytes and their evolutionary tendencies

Unit III

Emergence of first seeds plants, preovules, diversification of Gymnosperms in geological time scale. First Angiosperms, Angiosperm palaeofloristics; Concept of Indian Gondwana sequence, stratigraphy and correlation of Gondwana sequence in Peninsular Indian basins; Mega and microfloristics of Indian Gondwana formation; Indian Perigondwana floras

Unit IV

Applied Palaeobotany Life as fuel maker, sources of natural fossil fuels, Peat, coal and its varieties, constitution of coal, Coal Palynology, coal maceral, Petroleum – its origin, migration and concentratiohn, palynology in oil exploration

Unit V

Fundamentals of Paleofloristics, Palaeogeography and Palaeoclimatology; Application of Palaeopalynology .Plant and animal interactions correlation, Archaeobotany with special reference to phytoliths and palynological studies

Suggested readings:

1. Steward W.N., Palaeobotany and evolution of plant. Cambridge University Press,New York.405 p.(1)
2. Stewart,W.N.,and G.W.Rothwell.1993 Palaeobotany and the evolution of plant. 2nd ed. Cambridge University Press, New York.521 p.(1)
3. Andrews ,H.N.,jr.1974 Palaeobotany 1947-1972 Annals of the Missouri Botanical Garden 61:179-202.(8)
4. Thomas N.Taylor.Edith L. Tailor.MichaelKringsPalaeobotany:The biology and Evolution of Fossil Plants Amsterdam ; Boston, Mass.

BOT 104 E2:PLANT PATHOLOGY

Unit-I

General introduction to Plant Pathology, chemical weapons of pathogens – Enzymes and toxins; Role of growth hormones in plant diseases, Defense mechanism of the host, how the pathogen affects plant physiological functions

Unit-II

Genetics of plant disease, effect of environmental factors on the plant disease development, Plant disease epidemiology: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds

UNIT III

Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine, integrated pest management

Unit-IV

Diseases caused by fungi, bacteria, viruses and mycoplasma

Unit-V

Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defense response to plants

Suggested readings:

1. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology.8th edition, McGraw-Hill.

2. Agrios, G. N., 1988. Plant Pathology, Academic Press.

3. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.

4. Dickinson, C. M., 2003. Molecular Plant Pathology, Bios Scientific Publisher

5. Robert, N., Trigiano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.

6. Bridge, P.D and Clarkson, J.M., 1998. Molecular Variability of Fungal Pathogens, CAB, International

7. Singh, R. S., 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd

8. Singh, R. S., 2008. Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt Ltd.

9. Dhingra, O.D. and James, B. Sinclair, 1995. Basic Plant Pathology Methods, CRC Press

10. Pelczar, JM, Chan, ECS and Krieg, MR. 1993. Microbiology.Tata McGraw Hill.

11. Bishen, PS. 2014. Microbes in Practice.I.K. International Publishing House Pvt. Ltd.

12.Aneja, KR, Jain, P and Aneja, KR. 2008. A Text book of Basic and Applied Microbiology.New Age International Publishers, New Delhi.

BOT 104 E3: APPLIED PHYCOLOGY

Unit I

Marine environment an introduction, Culture medium and methods, Cultivation of macro and microalgae, Seaweed farming for potential application in food industries

Unit II

Seaweeds used as a source of agar, carrageenan, Alginate, Seaweeds used as human food, Fertilizers and soil conditioners, Animal feed, Fish feed

Unit III

Bioactive phenolic compounds in seaweeds, seaweed as a source of bioactive proteins, peptides and amino acids, lipid and fatty acid profile of major seaweeds, Minerals in edible seaweeds

Unit IV

Biomass for fuel, Cosmetics, Integrated aquaculture, Wastewater treatment, Treatment of wastewater to reduce nitrogen- and phosphorus-containing compounds, Removal of toxic metals from industrial wastewater

Unit V

Algae and human affairs: edible algae, algae in single cell protein production, algal biofertilisers, phycocolloids and other useful products of algae, biotechnological application of algae.

Suggested readings:

1. Lee, Robert Edeward, Phycology, Fourth edition 2008, Cambridge University Press

2. Graham Robin South and Alan Whittick, 1998, Introduction to Phyclogy, Blackwell Scientific Publication

3. Bold, H.C. and Wynne, M.J. ,1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.

4. Dixon, R. , Biology of Rhodophyta, Koelt Science Publisher, West Germany

5. Fritsch, F.E., Structure and Reproduction of Algae, Vol. I & II, Cambridge University Press, Cambridge

6. Gangulee, H.C. and Kar, A.K., 2011, College Botany Vol. II (Algae+Fungi+Brophyta+Pteridophyta) , New Central Book Agency, Kolkata

7. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae+Fungi+Brophyta+Pteridophyta) ,Pub.Rastogi Publication, Meerut

BOT 105: PRACTICALS BASED ON BOT 101, BOT 102 &BOT 103

1. Comparative investigation of gross morphology, extent of differentiation of cyanobacteria and eukaryotic algae 2. Collection of samples of algae and preparation of temporary and permanent mount of algae under study with identification 3. To examine and record the asexual and sexual reproductive features of some representative genera of algae

4. To examine and identify morphological and cellular features of an unknown fungal colony with unaided eye and using optical devices 5. To identify the stages of sexual reproduction of given fungi. 6. To examine the fruiting body of different fungi and distinguish among them 7. Prepare a scrap mount spores of puccinia ,ustilagoetc 8. Cut section of ascocarp of ascobolus

9. To examine the internal structure of a given Bryophytes 10. classify the bryophyte in one of the three groups on the basis of internal structure 11. Prepare the slides for examination of reproductive structures 12. Examine ,identify and describe the reproductive structures such as gemma cups, antheridia, archegonia and spore bearing structures 5. preparation of permanent slides

13 .Differential staining procedure 14. Rhizobium isolation from legumes 15. Serial dilution process and application 16. Replica plating technique 17. Sterilization techniques 18. Isolation and culture of microbes from given Samples

Pteridophytes: 19. Study of the following members to observe arrangement of Sori on a receptacle : - Isoetes, Osmunda, Angiopteris, Ceratopteris, Achrostichum. 20. Morphology, Anatomy and reproductive structures of : - Psilotum, Selaginella, Lycopodium, Equisetum, Ophioglossum, Lygodium, Pteris, Pteridium, Salvinia, Adiantum, Azolla. **Gymnosperms: -** 21. Morphology, Anatomy and reproductive structures of – Cycas, Zamia, Ginkgo, Pinus, Araucaria, Taxus, CedrusPicea, Thuja, Podocarpus, Gnetum, Ephedra.

BOT 106 APPLIED MICROBIOLOGY

Unit-I

Microbiology of Air, Microbiology of water, water treatment. Microbiology of Solid Wastes, Sewage (Waste water) and Industrial Waste, sewage treatment (domestic)

Unit-II

Food Microbiology: Food spoilage, microbiology of milk and dairy products, microbiology of fermented foods. Industrial Microbiology

Unit-III

Agriculture Microbiology: Microbes-Plant Associations, free-living, associative, symbiotic nitrogen fixers, actinorrhizae, stem nodulating Rhizobia, mycorrhizal associations, Microbial Biofertilizers and Biopesticides,

Unit-IV

Environmental Microbiology: Composting, vermicomposting, microbial bioremediation, merit, scope and approaches of bioremediation, ecology and technology of bioremediation, bio-deterioration.

Unit-V

Medical Microbiology: Infection and Diseases, Human Diseases caused by Fungi (mycoses; superficial, cutaneous, sub-cutaneous, systemic), Bacteriatheir diagnostics and managements

Suggested readings:

1. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan.

2. Dubey, RC and Maheshwari, DK. 1999. A Textbook of Microbiology. S. Chand & Company Ltd.

3. Atlas, RM. 1995. Principles of Microbiology.Mobsy.

4. Lim, DV. 2003. Microbiology. Kendall/Hunt.

5. Boundless.2013. Microbiology. Boundless Learning, Incorporated.

6. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology.Lippincott Williams & Wilkins.

7. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition.McGraw-Hill.

8. Tortora, G.J., Funke, B.R., Case, C.L. 2003, Microbiology: An Introduction. Benjamin Cummins

9. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill

BOT 107 BIO-FERTILIZERS

Unit-I

Biofertilizers: Definition and types, Importance of bio-fertlizers in agriculture. Characteristics of biofertilizers: *Rhizobium, Azotobactor*, *Azospirillum*, Phosphate-solubilizingMicroorganisms, cyanobacteria, *Azolla*, Mycorrhizae

Unit-II

Symbiosis: Physiology, biochemistry and molecular genetics of symbiosis. Enzymes and their regulation: Nitrogenase, hydrogenase.

Production technology:

Unit-III

Strain selection, sterilization, growth and fermentation, mass production of various biofertilizers.

Unit-IV

Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings.

Unit-V

Extension, promotion and marketing: Extension strategies, diagnosis for the effectiveness of inoculation, improvement in distribution system

Suggested readings

1. Dodd, J.C. and Thomson, B.D. (1994).The screening and selection of inoculantarbuscular-mycorrhizal and ectomycorrhizalfungi.*Plant and Soil* 159: 149-158.
2. Dommergues, Y.R. (1995). Nitrogen fixation by trees in relation to soil nitrogen economy.*Fertilizer Research* 42: 215-230.
3. Dommergues, Y.R. and SubbaRao, N.S. (2000).Introduction of N2-fixing trees in non-N2-fixing tropical plantations.In N.S. SubbaRao and Y.R. Dommergues(eds.), *Microbial interactions in agriculture and forestry*, Volume 2 (pp. 131- 154).
4. Enfield, NH: Science Publishers, Inc.
5. Elmes, R.P., Hepper, C.M., Hayman, D.S., and O'Shea, J. (1983). The use of vesicular-arbuscularmycorrhizal roots grown by the nutrient film technique as inoculumfor field sites. *Annals of Applied Biology* 104: 437-441.
6. Elmes, R.P. and Mosse, B. (1984).Vesicular-arbuscularmycorrhizal inoculum production.II. Experiments with maize *(Zea mays)* and other hosts in nutrient flow culture. *Canadian Journal of Botany* 62: 1531-1536.
7. Eom, A.-H., Hartnett, D.C., Wilson, G.W.T. (2000).Host plant species effects on arbuscularmycorrhizal communities in tallgrass prairie.*Oecologia*122: 435- 444.
8. Fontaine, M.S., Young, P.H., and Torrey, J.G. (1986).Effects of long-term preservation of *Frankia*strains on infectivity, effectivity, and in vitro nitrogenaseactivity.*Applied and Environmental Microbiology* 51: 694-698.
9. Frank, A.B. (1885). Über die auf WurzelsymbioseberuhendeErnährunggewisserBäumedurchunterirdischePilze. *Berichte der DeutchenBotanischenGesellschaft*3: 128-145.

2nd SEMESTER

BOT 201:ANGIOSPERMS-MORPHOLOGY, TAXONOMY, ANATOMY&EMBRYOLOGY

Unit I

Introduction of morphology and anatomy including brief historical account; External and internal organization of higher plants; Morphology of root and stem and their modifications, Ergastic substances; Microscopic and sub-microscopic structure and organization of cell wall

Unit II

Systematics: Historical perspectives. Outline of classification of Angiosperms; Bentham and Hooker, Hutchinson, Takhtajan, Cronquist, merits and Demerits.APG SYSTEM, Botanical nomenclature: International code of Botanic Nomenclature; principles: Rules and recommendations; priority; typification; Rules of effective and valid publications; retention and choice of names.

Unit III

Taxonomic featues, systematic phylogeny and economic importance of families**:** Magnoliaceae, Capparidaceae, Combretaceae, Rosaceae**,** Asteraceae, Apocynaceae, Asclepiadaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Bignoniaceae, Lamiaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Orchidaceae, Zingiberaceae, Araceae, Cyperaceae and Poaceae

Unit IV

Meristems: Organization of root apical meristem (RAM) and shoot apical meristem (SAM) differentiation; quiescent center, Xylem and phloem: Ontogeny and structure of components and phylogeny, transfer cells. Secretary and excretory structures; Primary structure of root and stem, Origin of lateral roots, root-stem transition, nodal anatomy and its evolutionary significance; Leaf –structure and function. Systematic significance of trichomes and stomata; Vascular cambium and its derivatives, Primary anomalies in stem and anomalous secondary growth, floral morphology and anatomy, fruits and seeds

Unit V

Developmental biology of male and female gametophytes: Regulation of anther and ovule development, microsporogenesis and microgametogenesis, megasporogenesis and megagametogenesis, male sterility-mechanisms and applications, pollen embryogenesis. Pollen-pistil interaction: *In vivo* and *in vitro* pollen germination, pollen tube growth and guidance, double fertilization, self-incompatibility mechanisms. Embryogenesis and seed development: Polarity during embryogenesis, pattern mutants, *in vitro* fertilization, endosperm development, apomixis, polyembryony, somatic embryogenesis

Suggested readings:

1. Bhatnagar SP and Moitra A (2005) Gymnosperms. New Age Interactive (P) Ltd. Publishers, New Delhi
2. Carlquist, S. (1961), Comparative Plant Anatomy, Holt, Rinehart and Winston, New York Press
3. Cutter, Elizabeth (1969), Plant Anatomy part –I Cells and Tissues IIndedition,EdwardArnold,London
4. Cutter, Elizabeth (1971), Plant Anatomy Part- II Organs, Edward Arnold London
5. Dickison William C. (2000), Integrative Plant Anatomy. Academic Press
6. Eames, A. J. & Mac Daniels Laurence H. (1951), An Introduction To Plant Anatomy, McGraw Hill.
7. Eames A.J (1961), Morphology of Angiosperms,McGraw-Hill,New York.
8. Esau, Katherine (1965), Plant Anatomy, John Wiley and Sons. Inc, New York.
9. Esau, Katherine, Anatomy of seed Plants (1960), Wiley, New York.
10. Evert, Ray.F.(1960), Esau's Plant Anatomy. John Wiley & Sons.
11. Fahn ,A. (1982), Plant Anatomy Vol I and Vol II Pergamon Press. Oxford New York
12. Mauseth, James D. (1988) Plant Anatomy. Benjamin/Cummings.

BOT 202: PLANT PHYSIOLOGY & BIOCHEMISTRY

UNIT I

Plant Water Relation: Transport and translocation of water and solute, soil plant atmosphere continuum (SPAC), recent concept in stomatal physiology, water potential and components, mechanism of water transport, mineral nutrition, nutrient uptake, solute transport, phloem loading and unloading.

UNIT II

Photochemistry and Photosynthesis: - History of photosynthesis, Photosynthetic pigments and apparatus , Light harvesting complexes, light reaction of photosynthesis, photo oxidation of water, mechanism of photophosphorylation, structure and function of RUBISCO and PEP carboxylases, Calvin cycle, photorespiration and its significance, C4 cycle and CAM pathway.

Respiration and nitrogen metabolism: - Overview of plant Respiration, EMP pathway, TCA cycle, glyoxylate cycle, Electron transport and ATP synthesis, pentose phosphate pathway, Cyanide resistance respiration and gluconeogenesis.

Nitrogen and sulphur metabolism: biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonia assimilation, sulphur assimilation, metabolic interrelation of nitrogen, carbon and sulphur metabolism.

UNIT III

Plant growth regulators: Biosynthesis and action mechanism of: Auxins, Gibberellins, (GA), Cytokinins, Ethylene and Abscisic Acid. Introduction of other hormones: Jasmonic acid, salicyclic acid, polyamines. Growth and development aspects: -Metabolic changes during seed germination, factor affecting seed germination and dormancy, breaking of dormancy, biochemistry of flowering: initiation and development of flower, induction of flowering: vernalization, physiology and biochemistry of leaf abscission and senescence. Stress Physiology: Biotic and abiotic stresses.

UNIT IV

Energy Dynamics:- Structure of atoms and molecules, chemical bonds, principles of thermodynamics, Bioenergetics, free energy, high energy molecules and redox potentials. Enzymology: -General classification, factors affecting enzyme activity, Enzyme Kinetics, mechanism of action and regulation, allosteric enzyme and Isoenzyme.

UNIT V

Carbohydrates:- General classification, structure and physio-chemical properties of carbohydrate, biological significance, important glycoprotein. Amino acids and proteins:- General classification, structure and physiochemical properties of amino acids; Proteins: structure, synthesis and physical and chemical properties of protein. Lipid: classification, structure and properties of important lipids, biological significance of lipid. Secondary metabolites:- General classification, major pathways and types and functions of secondary metabolites.

Suggested readings:

1. Buchanan B.B, Gruissem W. and Jones R.L 2000.Biochemistry andMolecular Biology of Plants.American Society of Plant Physiologistsm
Maryland, USA.

2. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. PlantMetabolism (Second Edition) Longman, Essex, England.

3. Galstone A.W. 1989. Life processes in Plants. Scientific American Library,SpringerVerlag, New York, USA..

4. Moore T.C. 1989.Biochemistry and Physiology of Plant Hormones Springer–Verlag, New York, USA.

5. Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. (2015). Plant physiology and Development 6th edition. . Sinauer Associates Inc., USA.

6. Salibury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.

7. Leninger A.C 1987. Principles of Biochmistry, CBS Publishers and Distributer

BOT 203: CELL & MOLECULAR BIOLOGY

UNIT I

Introduction: -Evolution of eukaryotic cell from prokaryotic cells.The Dynamics of Cell: - Structural organization of plant cell, sub cellular organization, Totipotency and cell differentiation, cytoplasmic matrix (Properties and organization).Biogenesis, Ultra structure and functions of- Cell wall. Plasma membrane .Plastids.Endoplasmic reticulum.Mitochondria.Golgiapparatus vii.Plasmodesmataviii.PlantVacuole.Nucleus.Ribosome.Lysosomes, Peroxisomes and Glyoxysomes.cell secretion, endosome, coated vesicle, intracellular trafficking and cell sorting.

UNIT II

Chromosomes: -Structure, Types, packing of DNA, Nucleosome organization, molecular organization of centromere and Telomere, Giant chromosomes. Cell cycle and apoptosis: -Mechanism of cell division, mitosis and meiosis, cell differentiation, control mechanisms, role of cyclins and cyclin dependent kinases cell-cell interaction,malignant growth, immune response, dosage compensation.

Unit III

Structure and conformation of nucleic acids; Replication of DNA; DNA damage and repair; Gene structure; Transcription of gene; Structure of mRNA, rRNA and tRNA, Regulation of transcription, Posttranscriptional modification of RNA, RNA editing; Transport of RNA

Unit IV

Protein synthesis: Genetic code, Mechanism of translation (initiation, elongation and termination); Post-translational modification; Protein sorting in the cell, Regulation of protein synthesis in prokaryotes and eukaryotes.

Unit V

Signal transduction: Overview of receptors and G-proteins, phospholipids signifying role of cyclic nucleotides, calcium- calmodulin cascade diversity in protein kinase and phosphates specific signaling mechanism, Secondary messengers; Gene silencing mechanisms, Epigenetics

Suggested readings:

1. Buchanan, B., Gruissem, W., & Jones, R.L., 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.

2. Lodish, Harvey, Berk , Arnold, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, HiddePloegh, Paul Matsudaira Molecular Cell Biology, 6th Ed. W.H. Freeman and Comp., New York

3. Bourton E. Tropp, Molecular Biology, 4th Ed., Jones &Barlett learning

4. Brown, T.A., DNA Cloning and Gene Sequencing Willey-Blackwell, Oxford

5. Genes IX by Benjamin Lewin, Jones and Barlett

6. Y Gerald Karp , Cell and Molecular Biology 6th Ed., John Willey & Sons

7. Nelson, D .L. and Cox, M.M., 2008, Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman & Co, New York, USA.

8. Cooper , G.M. and Robert, E. Hausman The Cell: A Molecular Approach 5th Ed . (Co-published by ASM Press and Sinaurer Assoc. Inc.)

9. Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M and Richard, L. 2008. Molecular Biology of the Gene. Pearson Education Inc.

BOT 204 E1: POLLINATION BIOLOGY

UNIT I

Plant Reproduction.Reproductive strategies and innovations.Mechanisms of pollen dispersal.Major plant lineages and the origin of the Angiosperms.*FloralEvolution*.The evolution of the flower and floral diversity. Floral Advertisement: Visual, Odorant. *Nectar, Pollen, and other floral rewards*.

UNIT II

Pollinator Evolution and Diversity Overview.The origin of pollinator lineages relative to the rise of the Angiosperms.Taxonomy and phylogenetics of pollinator lineages.*Beetles, Wasps, and generalist insect pollinators.Lepidoptera and FliesBees*.*Non-insect pollinators*.Bats, Birds, and other vertebrates.

UNIT III

Evolution of pollination strategies, pollination syndromes, mutualisms and deceptive pollination.*Specialists vs. generalists*. Case studies in plant-pollinator coevolution.

UNIT IV

Foraging Economics.Maximizing foraging efficiency (e.g., patch size, foraging distance, thermoregulation, sampling strategies).*Recruitment and Learning*.e.g.,traplining, specialization, landscape memory, floral marking, communication.*Landscape and Community Ecology*.Pollinator and plant communities and networks.Importance of nest sites, foraging distances, plant phenology, habitat availability.*Pollination in different habitats*.

UNIT V

Importance of Pollinators in Agriculture: animal pollinated vs. wind pollinated crops, key pollinators, research on agriculturally important pollinators. *Commercial pollination services*: honeybees, Megachilid bees, bumble bees. Methods of maximizing native pollinators for crop pollination.*The Human-Pollinator Connection*: pollination and human health. *Contributing factors*.Habitat Fragmentation in Agricultural Landscape, Climate Change, Pesticide/Herbicide Use, PollinatorPathogens.*Notable Declines: Honey bees*. *Notable Declines: Bumble bees and Native Pollinators*

Suggested readings:

1. Annals of Botany, (2009). Special issue on Plant-Pollinator Interactions. Oxford University Press, Oxford, UK.
2. Barrett, S.C.H. (editor). (2008). Major evolutionary transitions in flowering plant reproduction. University ofChicago Press, Chicgao, IL, USA.
3. Barth, F. G. (1985). Insects and Flowers: The Biology of a Partnership. PrincetonUniversity Press, Princeton, NJ, USA.
4. Bernhardt, P. (1999). The Rose's Kiss: A Natural History of Flowers. Universityof Chicago Press, Chicago, IL, USA.
5. Faegri, K. & L. van der Pijl. (1979). The Principles of Pollination Ecology (3rdedition). Pergamon Press, Oxford, UK.
6. Harder, L. D. & S. C. H. Barrett (editors), (2006). Ecology and Evolution of Flowering Plants. Oxford University Press, Oxford, UK.
7. Leins P. & C. Erbar. (2010). Flower and Fruit: Morphology, Ontogeny, Phylogeny, Function and Ecology. Schweizerbart Science Publishers,
8. Stuttgart, Germany. Proctor, M, P. Yeo, & A. Lack. (1996). TheNatural History of Pollination. Harper- Collins Publishers. London, UK.
9. Waser, N. M. & J. Ollerton (Editors).(2006). Plant-pollinator Interactions:from Specialization to Generalization. University of Chicago Press, Chicago,IL, USA
10. Willmer, P. (2011). Pollination and Floral Ecology. Princeton University Press,Princeton, USA. Pollination in Agriculture

11. Free, J. B. (1993). Insect Pollination of Crops (2nd edition). Academic Press,London, UK.
12. Delaplane, K. & D. Mayer. (2000). Crop Pollination by Bees. CABI International,Wallingford, UK.
13. James, R.R. & T. Pitts-Singer (editors).(2008). Bee Pollination in Agricultural Ecosystems. Oxford University Press,Oxford, UK.
14. K. Strickler and J. Cane (Editors). (2003). Non-native Crops: Whence Pollinatorsof the Future? Thomas Say Publications in Entomology, Entomological Society of America, Lanham, MD, USA.
15. C. S. Stubbs & F. A . Drummond (Editors). (2001). Bees and crop pollination –Crisis, crossroads, conservation. Thomas Say Publications in Entomology, Entomological Society of America, Lanham, MD, USA

BOT 204 E2: PHOTOBIOLOGY OF CYANOBACTERIA

UNIT I

Genetic structure of the N2 fixation system, molecular mechanisms of heterocyst differentiation and metabolism, genetic aspects of nitate, nitrite and ammonia assimilation

UNIT II

Accessory light harvesting complex: Phycobilisomes, phycobiliproteins, linker polypeptides, energy transfer, gene organization, chromatic adaptation.

UNIT III

Photobiology: Photobiological aspects of UV-induced damage and repair in cyanobacteria

UNIT IV

Mycosporine-like amino acids (MAAs), scytonemin. Cyanobacterial toxins: Types of cyanobacterial toxin, molecular tools for the identification of toxic

UNIT V

Cyanobacteria, biochemical, ecological implications.Basic strategies for the generation of transgenic cyanobacteria

Suggested readings:

1. Lee, Robert Edeward, Phycology, Fourth edition 2008, Cambridge University Press
2. Graham Robin South and Alan Whittick, 1998, Introduction to Phyclogy, Blackwell Scientific Publication
3. Bold, H.C. and Wynne, M.J. ,1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.
4. Walker,D.1992, Energy, Plants and Man, 2nd Edition, University of Sheffield

BOT 204 E3:FLORISTIC DIVERSITY

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones. Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers

Suggested Readings

1. Arora JS. 2006. Introductory Ornamental horticulture. Kalyani.Bhattacharjee SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Bose
2. TK &Yadav LP. 1989. Commercial Flowers. NayaProkash. Bose TK, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping.NayaProkash. Chadha KL &Chaudhury B. 1992.Ornamental Horticulture in India.ICAR.

BOT 205:PRACTICALS BASED ON BOT 201, BOT 202& BOT 203

1. Identification of different stages of mitosis and study of morphology of metaphase chromosomes from Onion root meristems. 2. Identification of different stages of meiosis from suitable plant material. (Onion Buds). 3. Orcein staining of salivary gland chromosomes of Chironomas or Drosophila. 4. Isolation of cell organelles: Mitochondria, Chloroplast, Nucleus, the assay by succinate dehydrogenase activity(Mitochondria), acid phosphatase activity (Lysosomes), acetocarmine staining (Nucleus) and Microscopic observation (Chloroplast). 5. Study of mitotic index from suitable plant material. 6. Techniques of preparation of permanent and semi permanent slides.

6. Test for viability of seeds. 7. Measurement of water potential of a plant tissue 8. Separation of leaf pigments by chromatography. 9. Induction of Nitrate reductase by nitrate ion and light. 10. To observe elongation of coleoptiles by treatment with 2,4-D. 11. To determine the activity of enzyme amylase in germinating seeds and its induction by GA. 12. Hill Reaction.

13. Preparation of i) solutions of different molarity and normality. ii) Buffers of different molarity and pH. 14. To demonstrate the action of Xanthine oxidase, phenolasecomplex . 15. To determine the units of activity and specific activity of □- amylase enzyme. 16. Qualitative test for organic constituents of cells 17. Separation of isozymes of peroxidases by native polyacrylamide gel electrophoresis. 18. To study biochemical changes during leaf senescesnce. 19. Desalting of proteins by gel filtration chromatography employing sephadix G – 25. 20. Separation of pigments by paper chromatography and TLC

21. Methods of non-destructive field collection and documentation. 22. Techniques of herbaria preparation.23. Morphological characterization of selected families of dicots (10 families) and monocots (5 families) and identification upto families. 24. Preparation of artificial key (at least five) based on appropriate character combination. 25. Identification of genus and species from – (at least ten) Monocots and Dicots

BOT 206: FOOD PROCESSING

UNIT I

Food items; Fermented food, wine, bakery products, cereals, and milk products.

UNIT II

Spoilage of food products including cereals, fruits, vegetables, meat, fish, and dairy products.

UNIT III

Milk and milk products, source of their contamination and control.

UNIT IV

Starter cultures.Microbiological legal standards of selected food and milk products.Food poisoning and microbial toxins produced in food items and dairy products.

UNIT V

Food preservatives and their uses.Mushroom cultivation technology and single cell protein

Suggested readings:

1. Alfa-Laval. *Dairy Handbook*. Alfa-Laval, Food Engineering AB. P.O. Box 65, S-221 00 Lund, Sweden. [Well illustrated text. Excellent introduction to dairy technology]. American Public Health Association, *Standard Methods for the examination of dairy products*. 1015 Eighteenth St. NW, Washington, D.C.
2. Battistotti, B., Bottazzi, V., Piccinardi, A. and Volpato, G. 1983. *Cheese: A guide to the world of cheese and Cheese making*. Facts on File Publications, New York, NY.
3. Berger, W., Klostermeyer, H., Merkenich, K. and Uhlmann, G. 1989. *Processed Cheese Manufacture,* A JOHA guide. BK Ladenburg, Ladenburg.
4. Chandan, R. 1997. *Dairy Based Ingredients*. Amer. Assoc. Cereal Chemists, St. Paul, Minnesota.
5. Davis, J.G. 1965. *Cheese*. American Elsevier Publ. Co., New York.
6. Eck, A. and Gillis, J.-C., 2000. *Cheesemaking from Science to Quality Assurance*, Lavoisier Publishing, Paris..
7. Emmons, D.B., Ernstrom, C.A., Lacroix, C. and Verret, P. 1990. Predictive formulas for yield of cheese from composition of milk: a review. *J. Dairy Sci*. 73: 1365-1394.
8. Fox, P.F., Guinee, T.P., Cogan, T.M., McSweeney, P.L.H. 2000. *Fundamentals of Cheese Science.* Aspen Publishers, Inc. Gaithersburg, Maryland.
9. Hill, A.R. 1995. Chemical species in cheese and their origin in milk components. In *Chemistry of Structure Function Relationships in Cheese*, E.L. Malin and M.H. Tunick, Editors. Plenum Press, NY.
10. Masui, K..and Yamada, T. 1966. French Cheeses: *The Visual Guide to More than 350 Cheeses From Every Region of France*.
11. DK Publishing, New York.Official Methods of Analysis of the Association of Official Agricultural Chemists, P.O. Box 540, Benjamin Franklin Station, Washington, D.C.

BOT 207: STATISTICAL METHODS

UNIT I

General concepts and term, concepts of biostatistics.Sampling methods

UNIT II

Measures of location scale and shape. Contingency tables and chi-square test

UNIT III

Comparison of means: t-test, multiple range tests.

UNIT IV

Simple experimental design and analysis of variance

UNIT V

Correlation and regression analysis.Introduction to multivariate methods

Suggested Readings;

1. P.K Gupta1992, Biostatistics,P.S verma1990,Biostatistics (Third Edition). Jones and B. Artlet Publisher, Inc., London.
2. **Russel, P.J.** 1998. Genetics (Fifth Edition). The Benjamin/CummingsPublishing Company IND., USA.
3. **Snustad, D.P and Simmons, M.J** 2000.Principles of Genetics (SecondEdition).John Wiley and Sons Inc., USA.
4. **Gardner and Simmons Snustad**2005 (Eighth Edition).Principles ofGenetics,John Wiley and Sons, Singapore.
5. **Sariu C** 2004 (Sixth Edition) Genetics. TATA McGraw-Hill PublishingCompany Ltd., New Delhi.

3rd SEMESTER

BOT 301: MORPHOGENESIS, TISSUE CULTURE & DEVELOPMENTAL BOTANY

Unit I

Morphophogenesis-Introduction, various theories; differentiation and development, Morphogenetic phenomenon: Symmetry, polarityand correlation

Unit II

Plant cell and tissue culture: General introduction, history and scope; Tissue culture techniques and culture media; Experimental embryology, anther, ovary and endosperm culture; somatic embryogenesis and androgenesis

Unit III

Somatic hybridization: Protoplast isolation, culture and regeneration, Somatic hybridization and hybrid selection; Possibilities, achievements and limitations of protoplast research; Applications of plant tissues culture: clonal propagation, artificial seed, production of hybrids and soma clones, production of secondary metabolites/ natural products; Cryopreservation and germplasm storage

Unit IV

Ovule: Ontogeny, structure, integuments and nucellus specialized structures, megasporogenesis; Development of embryo sac, subcellular details of constituent cells and their function, major types.

Unit V

Pollen-pistil interaction: Role of pollen wall proteins and stigma surface proteins, pollen tube growth in pistil, fertilization and apomixes; Endosperm: Major types, ultrastructure and histochemistry; Embryo: major types, polyembryony; Embryology in relation to Taxonomy

Suggested readings:

1. Bhojwani, S.S. and Bhatnagar, S.P.(1985), Embryology of Angiosperms, Vikash Publishing House, New Delhi

2. Johri, B.M (1984) Embryology of Angiosperms.Springer-Verlog Berlin Heidelberg.

3. Maheshwari, P. (1950) An Introduction to the Embryology of Angiosperms.Tata McGraw Hill.

4. Pandey, B.P., Angiosperms-Taxonomy, Emrbyology and Anatomy, S. Chand and Co., New Delhi

5. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi

6. Butenko RG (2000) Plant Cell Culture, University Press of Pacific.

7. Davies PJ (2004) Plant Hormones, Kluwer Academic Publishers, Netherlands.

8. Halford N (2006) Plant Biotechnology - Current and future applications of genetically modified crops, John Wiley and Sons, England

BOT 302: GENETICS, PLANT BREEDING & ORGANIC EVOLUTION

Unit I

Mendelian and post mendelian genetics with historical perspectives , gene interaction, epistasis, lethal genes. Qualitative and Quantitative traits, Continuous variation, Inheritance of quantitative traits, (corolla length in Nicotiana, cob length in Zea mays), multiple factors hypothesis and heritability

Unit II

Concept of Linkage, Types and Applications, Concept and Types of Recombination, estimation of recombination percentages and map distances, Gene mapping in Fungi using ordered and unordered tetrads of Neurospora and yeast. Three point test crosses and estimation of linkage distances in plants. Gene maps and physical maps.Population genetics: - Gene and genotype frequencies, Hardy-Weinberg law, Factors affecting HardyWeinberg equilibrium (selection, mutation, migration and genetic drift).

Unit III

Cytogenetics of haploids: Haploidy/monopolidy, meiosis and breeding behaviour of haploids, uses of haploids in plant breeding. Induction and characterization of monosomics, trisomics and nullisomics, inheritance pattern in autopolyploids, status of allopolyploids in plant evolution

Chromosome banding patterns: Linear differentiation of chromosome segments, types of chromosome banding, uses of chromosome banding in cytogenetics.

Unit IV

Plant breeding and crop improvement: Objectives and scope of plant breeding, hybridization in self- and cross-pollinated crops, genetic basis of inbreeding depression and heterosis, breeding for disease and insect resistance, transgenes and transgenic plants

Unit V

Alien gene transfer through chromosome: Transfer of gene through individual chromosome, characterization and utility of alien addition and substitution lines. Various theories of organic evolution, Synthetic theory, Speciation.

Suggested reading:

1. Clark, M.S. and Wall, W.J. 1996, Chromosomes : The Complex Code. Chapman & Hall, London.

2. Stebbins, G.L.1950, Variation and Evolution in Plants. Columbia Univ. Press, New York.

3. Swanson, C. P., Mertz, T.F. and Young, W.J. Cytogenetics : The Chromosomes in Division, Inheritance and Evolution (2nd Edn). Englewood Cliff, Prentice-Hall, New Jersey.

4. Sharma, A.K. and Sharma, Archana. 1985. Advances in Chromosome and Cell Genetics. Oxford & IBH Publishing Co., Calcutta.

5. Schnedl, W..Banding patterns in chromosomes. In: International Review of Cytology (Suppl. 4).

6. Lewine, Benjamin, Jones and Bartlet, Genes X, Sudburry, Masschusetts

7. Gupta, P.K., Cytogenetics, Rastogi Publication, Meerut

8. Peter, D, Snustand and Simmons, M.J., John Wiley and Sons Inc.

BOT 303: PLANT ECOLOGY & ENVIRONMENT

Unit-I

Introduction to ecology, and environment terminology; Population dynamics: Characteristics of a population, population growth curves, density dependent and independent population regulation, population structure, energy portioning, r and k selection, concept of carrying capacity and concept of metapopulation.

Unit-II

Community Ecology: Nature of communities, analysis of community (analytical and synthetic characters), community coefficients, competition, ecological niche; Levels of species diversity and its measurement, edges and ecotone, life forms, behaviour ecology.

Unit-III

Ecological succession: Types, mechanisms, change involved in succession, relay and floristic models, concept of climax, theories of succession, models of succession; biotic interactions: types of positive and negative interactions.

Unit-IV

Ecosystem Ecology: Ecosystem – structure and function, major ecosystems, primary production and measurement, structure and function of terrestrial and aquatic ecosystems. Energy dynamics (trophic organization, energy flow pathway, energy quality and ecological efficiencies), biogeochemical mineral cycling (C, N, P).

Unit-V

Applied Ecology: Environmental pollution: air and water pollution (types, source and effects of pollutants); green-house gases, green-house effect and global warming, ozone layer depletion and acid rain; Biodiversity: Threatened and endangered species, role of biodiversity in ecosystem stability, biodiversity management, in situ and ex-situ conservations, wildlife sanctuaries and national parks, hotspots and biosphere reserves, bio geographical regions of India.

Suggested reading:

1. Odum, E. P. and Barret G.W. 2005. Fundamentals of Ecology.Cengage publication
2. Singh, J.S., Singh S.P. and Gupta S.R. 2006. Ecology Environment and Resource Conservation.Anamaya Publishers
3. Singh, A. 2022. Concepts of Ecology and Environment.Pragati Publication

BOT 304 E1:ENRIVONMENTAL QUALITY ASSESSMENT

Unit-I

Methods of collection and analyses of gaseous and particulate pollutants, Stack monitoring. Methods of collection of water samples and analyses of physico-chemical characteristics.

Unit-II

Methods of collection of soil samples and analyses of physico-chemical characteristics.Bio-monitoring and bio-indication.Principles of chromatography, spectrophotometry, electro-analytical and radio-analytical techniques.

Unit-III

Environmental Management: concept and strategies.Environment and sustainable development, indicators, economic valuation of environmental resources.Environmental Management System (EMS): ISO-14000, EMS-audit, Environmental clearance for establishing industries.

Unit-IV

Environmental Impact Assessment (EIA); EIA guidelines 1994, Environmental impact analysis and statement,Environmental cost-benefit analysis and fiscal incentives.

Unit-V

International efforts on environmental management, Intellectual property rights (IPRs), Corporate environmental ethics

Suggested readings:

1. Peavy, H., Rowe D. &Tchobanoglous, G. (1985). *Environmental Engineering*. New York: McGraw-Hill.
2. Milnes, R. (2014). *Environmental engineering: principles and practice.* Hoboken: Wiley.
3. Manahan, S. E. (2009). *Fundamentals of environmental chemistry*(3rd ed.). Boca Raton: CRC Press/Taylor and Francis.
4. Keith, L. H. (Ed.) (1996).*Principles of environmental sampling* (2nd ed.). Washington, DC: American Chemical Society.

BOT 304 E2: VEGETATIVE PROPAGATION

Unit I

Introduction and importance of propagation.Structures, media fertilizers, sanitation and containers, Source selection of superior phenotype and management in vegetative propagation

Unit II

Techniques of propagation by cutting, grafting, budding and layering and its natural modification.Propagation of selected plants and rootstock for the important wild fruit species.Bud orchard.

Unit III

Introduction and importance of nursery.Types of nurseries.Bareroot, containerized and vegetatively produced nursery. Bare root nursery –nursery soil and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing.

Unit IV

Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and out –planting.

Unit V

Containerized nursery –type and size of container including root trainers, selection of growing medium. Types of green house and mist propagation

Suggested readings:

1. F. Gyuro: Fruit production. University of Horticulture, Budapest, Hungary (1980)
2. Dr. Cselotei-Dr. Nyujto-Csaki: Horticulture, MezogazdasagiKiado, Budapest, Hungary (1985) Growing fruit trees. Forestry Commission,
3. Harare, Zimbabwe MacMillen: Avocado. Technical Centre for Agricultural and Rural Cooperation (1995)
4. J.N. Moll-R. Wood: An efficient method for producing rooted avocado. Citrus and Subtropical Research Institute, Bulletin 99, Nelspruit, South Africa (1980)
5. B.O. Bergh: Avocado breeding in California. South African Avocado Growers Association Yearbook 10 A.
6. Chandra-A. Chandra-I.C. Gupta: Arid fruit research. Scientific Publishers, Jodhpur, India (1994) H. Kamprath: Proposal for a fruit tree orchard.
7. GTZ DED, Blantayre, Malawi (2003) Sowing of tree seed into pots. Department of Forestry, Lilongwe,
8. Malawi (1999) Care of young seedlings. Department of Forestry
9. Lilongwe, Malawi (1999) Planning a new nursery. Department of Forestry, Lilongwe, Malawi (1999) Seedling growth in pots. Department of Forestry
10. Lilongwe, Malawi (1999) L.P. Stoltz-J. Strang: Reproducing fruit trees by graftage: Budding and Grafting. University of Kentucky-College of Agriculture (2004)

BOT 304 E3: INSTRUMENTATION

Unit I

Microscopy: Simple, Compound, Phase contrast, Fluorescence, Electron (SEM andTEM) microscopy, Micrometry

Unit II

Centrifugation: - Rotors, Bench top, Low speed, High speed, Cooling and Ultracentrifuge**.**Techniques of Centrifugation, Separation of Sub-cellular Fractions, Ultracentrifugation, isopycnic, density gradient centrifugation

Unit III

Buffers and Solutions, Definition and Principle of Electrophoresis, Agarose Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE), Native PAGE, SDS-PAGE; 2D-Electrophoresis,Isoelectric Focusing (IEF): Principles

Unit IV

Chromatography: Basic concept, Paper, TLC, HPLC, GC, Size-exclusion chromatography, Ion-exchange chromatography, Hydrophobic Interaction chromatography and Affinity chromatograph; Labeling Techniques: Radiolabeling and Fluorescent labeling of biomolecules and their detection, Safety guidelines

Unit V

Biophysical Techniques: Spectroscopy - Basic Concept, MALDI-TOF, Mass Spectroscopy, X-Ray Diffraction, FTIR, NMR and ESR Spectroscopy

Suggested readings:

1. Wilson, K. and Walker, J., 2000, Practical Biochemistry: principles & techniques. Cambridge University Press.ISBN 0521799651.

2. Buchanan, B., Gruissem, W., & Jones, R.L., 2002, Biochemistry and Molecular Biology of Plants. American Society of PlantBiologists, USA.

3. Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M and Richard, L. 2008. Molecular Biology of the Gene. Pearson Education Inc.

4. Nelson, D .L. and Cox, M.M., 2008, Lehninger Principles of Biochemistry, W. H. Freeman & Co, New York, USA

BOT 305: PRACTICALS BASED ON BOT 301, BOT 302 & BOT 303

1. To determine the minimum size of the quadrat by species area curve method. 2. To study the communities by quadrat method and to determine % frequency, Density, and Abundance. 3. To determine the Biomass of a particular area 4. To determine the amount off dissolved oxygen in pond water 5. To determine the total dissolved solids and chlorides in water. 6. Estimation of salinity of water samples.
7. Mathematical problems based on Mendelian genetics (Test of goodness of fit), 8. Induction of polyploidy using colchicine; preparation of C-metaphase and karyotyping 9. Effect of physical/chemical mutagens on early seedling growth (Germination) and isolation of chlorophyll mutants following irradiation and treatment with chemical mutagens. 10. Study of meiosis in complex translocation heterozygotes (Rhoeo discolor) 11. Study of quantitative inheritance in suitable plant material. 12. Study of apical meristems with the help of dissections, whole mount preparations,sections and permanent slides. 13. Origin and development of epidermal structures (trichomes, glands and lenticels). 14. Study of xylem and phloem elements using maceration, staining, light and electron micrographs (xerophytes, hydrophytes and halophytes). 15. Study of secretory structures (nectaries and laticifers). 16. Study of secondary growth (normal and unusual) of selected woods with the help of wood microtome and permanent slides. 17. Pollen *in vitro* germination methods: Sitting drop culture, suspension culture, surface culture. 18. Study of post-fertilization stage with the help of permanent slides and electron micrographs. 19. Dissection of embryo and endosperm.
20. Preparation of different types of standard tissue culture media. 21. Establishment of aseptic cultures following appropriate sterilization procedures using seeds. 22. Preparation of competent cells and *Agrobacterium* transformation by electroporation. 23. *Agrobacterium tumefaciens*-mediated transformation of tobacco. 24. Visualization of GFP or YFP in transgenic *Arabidopsis*. 25. Morphological and histochemical features of major cereals, oilseeds, legumes, forest trees, non-alcoholic beverages and medicinal plants. 26. Analysis of crude extracts from medicinal plants using HPLC. 27. Evaluation of a transgenic phenotype (viz., Herbicide resistance) under containment conditions in the field.
28. Smear Preparation in allium cepa, Zea mays, Delphinium 29. Meiotic analysis in plants at pachytene level 30. Study of aneuploidy and chromosome mapping. 31. Cytological analysis of polyploidy in plants. 32. Genome analysis in Wheat/Gossypium 33. Study of apomictic chromosome.

BOT 306: POMOLOGY

Unit-I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

Unit-II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources: conservation in situ and ex situ.

Unit-III

Germplasm conservation. Problem of recalcitrance. Plant quarantine.

Unit-IV

Intellectual property rights, regulatory horticulture. GIS and documentation of local biodiversity

Unit-V

Geographical indication of following crops: Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard apple, ber, aonla, apple, plum, litchi

Suggested readings:

1. Jackson J. E. (2003) The biology of apples and pears Cambridge University
2. *Modern Fruit Science.*by Norman Childers, Justin R. Morris, and G. Steven Sibbett. Horticultural Publications. 3906 NW 31 Place.,
3. Gainesville, FL 32606. Phone: 904-372-5077. This classic textbook is on its tenth printing and was recently totally revised and updated. It is invaluable to those working in the field who wish to get a "hands-on" approach to fruit growing.*The Peach, World Cultivars to Marketing*. N. F. Childers and W. B. Sherman (eds.) Horticultural Publications. 3906 NW 31 Place.,
4. Gainesville, FL 32606. This text is a compilation of articles by the foremost scientists in peach research and extension.*The Pear, Cultivars to Marketing.*
5. T. van der Zwet and N. F. Childers (eds.) Horticultural Publications. 3906 NW 31 Place.,
6. Gainesville, FL 32606. This text is a compilation of articles by the foremost scientists in pear research and extension.*Temperate Zone Pomology.*by M. N. Westwood. Timber Press, 9999
7. S.W. Wilshire, Portland, Oregon 97225. This text is suitable as a second level textbook dealing in fruit production. The major emphasis being placed on tree physiology.

Physiology of Temperate Zone Fruit Trees.byMiklos Faust.John Wiley & Sons,

8. Wiley-Interscience, 605 Third Ave., New York, NY, 10158-0012. The text provides basic plant physiology as related to fruit trees.

BOT 307: FORESTRY

Unit 1

Forests: Introduction, Classification of forests in India-Tropical Evergreen Forests, Tropical Deciduous Monosoonic Forests, Tropical Grasslands, Arid Thorny Vegetation, Deltaic Forests, Mountainous Forests

Unit 1I

Introduction, scope and importance of wood based industries in relation to Indian economy; brief description of types of wood based industries in India

Unit III

Social Forestry: Introduction, aims, forms, scope and its application

Unit 1V

Agro-Forestry: Introduction, aims, forms, scope and its application

Unit V

Forests Protection policy, Rules and regulations in India

Suggested readings:

1. Handbook of forestry by LS Khanna and AN Chaturvedi – Part I and II
2. Indian forestry by Manikandan and Prabhu

4th SEMESTER

BOT 401: PLANT DIVERSIFICATION & RESOURCE UTILIZATION

Unit 1

Concept of centres of origin, their importance with reference to Vavilov's work; examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasmdiversity.Wheat and Rice, Role of dwarf varieties in green revolution; brief account of millets and pseudocereals. Legumes General account, importance to man and ecosystem; chief pulses grown in India.

UNIT II

Fruits- Mango, Citrus, Papaya. Sugars and starches- Ratooning and nobilization of sugarcane, products and by products of sugarcane industry; Potato (Tuber anatomy and propagation methods) and comparative account with cassava.Spices Listing of important spices, their family and part used; with special reference to fennel, saffron, clove, turmeric and all spices; common adulterants of spices. Beverages- Tea, coffee and cocoa, their processing and some common adulterants.

UNIT III

Oils and Fats- General description with details of groundnut, coconut, linseed and *Brassica*sppand their use relatedhealth implications. Essential Oils- General account and comparison with fatty oils.

UNIT IV

Natural Rubber- Para Rubber, tapping and processing, Various substitutes of Para Rubber.Drug Yielding Plants- Therapeutic and habit forming drugs with special reference to *Cinchona*, *Digitalis*, *Rauvolfia*,*Papaver*and *Cannabis.* Masticatories and Fumitories - Tobacco and Health hazards.

UNIT V

Timber plants- General account with special reference to teak and pine. Fibres- Classification based on the origin of fibres, Tetraploid cotton and jute.

Suggested readings:

1. Takhtajan,A 1997,diversity and classification of flowering plants
2. Kochhar, S.L 1998,Economic botany in the tropics
3. B. Choudhary 1992 Vegetables
4. WickenHill,A1976, A.V.S Sambamurty 1989 Economic botany

BOT 402: BIOTECHNOLOGY & GENETIC ENGINEERING

Unit I

A brief introduction to Biotechnology; Recombinant DNA technology: Restriction endonucleases, DNA Modifying enzymes, DNA polymerases; Vectors, Markers and reporter genes, Cloning, Screening of recombinant clone

Unit II

Polymerase chain reaction: Principle, method, variants and practical applications; cDNA, Gene cloning and identification: Genomic and cDNA library, Hybridization techniques: Southern, northern and western hybridization; FISH;

Unit III

Methods of gene transfer, Agrobacterium mediated genetic transformation of plants, Regeneration methodologies and Screening of transformants;\

Unit IV

Genetic engineering and its applications in Agriculture: Genetic manipulation of pest resistance, abiotic and biotic stress tolerance, Molecular farming; Transformation of chloroplast genome and its advantage; Biosafety concerns in Plant Biotechnology

Unit V

Molecular markers: RFLP, RAPD, AFLP, SSR, SNP**;** Functional genomics: Quantitative Real Time PCR, Microarray, RNA interference, Mutagenesis and Genome editing, Protein Production strategies in Expression System; Metagenomics

Suggested readings:

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine & R. Losick Molecular Biology of the Gene, Cold Spring Harbor Laboratory

2. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and application of recombinant DNA ASM Press, Washington, D.C

3. T. A. Brown, Genomes - Garland Science (Taylor & Francis Group), New York & London

4. Alberts Bruce, Johnson Alexander, Lewis Julian, Raff Martin, Roberts Keith and Walter Peter Molecular Biology of the Cell - Garland Science

5. Lodish, Harvey, Berk Arnold, et. al.,-Molecular Cell Biology.

6. Introduction to plant biotechnology by H S Chawla

7. Elements of biotechnology by P K Gupta

8. S H Mantell, *et. al.*by Principles of Plant Biotechnology: An introduction to genetic engineering in plants

9. Plant Biotechnology by B. D. Singh, Kalyani Publications

BOT 403: DISSERTATION

The dissertation has to be undertaken by students in any one of the following fields of specialization

1. **Bryology**
2. **Algal Biotechnology**
3. **Plant pathology**
4. **Microbiology**

BOT 404 E1: PLANT PROTECTION

Unit-I

General introduction to Plant Pathology, chemical weapons of pathogens – Enzymes and toxins; Role of growth hormones in plant diseases, Defense mechanism of the host, how the pathogen affects plant physiological functions

Unit-II

Genetics of plant disease, effect of environmental factors on the plant disease development, Plant disease epidemiology: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds

UNIT III

Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine, integrated pest management

Unit-IV

Diseases caused by fungi, bacteria, viruses and mycoplasma

Unit-V

Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defense response to plants

Suggested readings:

1. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology.8th edition, McGraw-Hill.

2. Agrios, G. N., 1988. Plant Pathology, Academic Press.

3. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.

4. Dickinson, C. M., 2003. Molecular Plant Pathology, Bios Scientific Publisher

5. Robert, N., Trigiano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.

6. Bridge, P.D and Clarkson, J.M., 1998. Molecular Variability of Fungal Pathogens, CAB, International

7. Singh, R. S., 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd

8. Singh, R. S., 2008. Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt Ltd.
9. Dhingra, O.D. and James, B. Sinclair, 1995. Basic Plant Pathology Methods, CRC Press
10. Pelczar, JM, Chan, ECS and Krieg, MR. 1993. Microbiology.Tata McGraw Hill.
11. Bishen, PS. 2014. Microbes in Practice. I.K. International Publishing House Pvt. Ltd.
12. Aneja, KR, Jain, P and Aneja, KR. 2008. A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi

BOT 404 E2: BIOINFORMATICS

Unit I

Bioinformatics: Introduction, Databases (Genomic and Protein Database), Similarity Searching: BLAST and FASTA;

Unit II

Tools for DNA, RNA and Protein sequence analysis, ExPASy-PROSITE

Unit III

Sequence Retrieval Methods, Primer Designing tools, Gene Prediction, Restriction Site Annotation, ORF Finder, Sequence Alignment; Molecular evolution and analysis methods

Unit IV

Bioethics: Concept of bioethics, benefits and harm, consent, privacy and confidentiality, sharing of benefits; Intellectual Property Right: Definition of IPR, World Intellectual

Unit V

Property Organization (WIPO) and its role; Patent: kinds of patent classification, patent criteria, Procedure of obtaining patent, copy right and trade mark, Organization of patent offices in India

Suggested readings:

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine & R. Losick Molecular Biology of the Gene, Cold Spring Harbor Laboratory
2. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and application of recombinant DNA ASM Press, Washington, D.C
3. T. A. Brown, Genomes - Garland Science (Taylor & Francis Group), New York & London
4. Alberts Bruce, Johnson Alexander, Lewis Julian, Raff Martin, Roberts Keith and Walter Peter Molecular Biology of the Cell - Garland Science
5. Lodish, Harvey, Berk Arnold, et. al.,-Molecular Cell Biology.
6. Introduction to plant biotechnology by H S Chawla

BOT 404 E3: BIOENERGY

UNIT I

Bioenergetics: Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions.

UNIT II

Intermediary Metabolism: Approaches for studying metabolism.

UNIT III

Coenzymes and Cofactors: Role and mechanism of action of NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with specific examples.

UNIT IV

Carbohydrates: Glycolysis, various forms of fermentations in micro-organisms, citric acid cycle, its function in energy generation and biosynthesis of energy rich bond, pentose phosphate pathway and its regulation.

UNIT V

Amino Acids: General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids.

Suggested readings:

1. Dler, D. 1999. Personal communication from Deborah Adler, ethanol analyst, Environmental Protection Agency, to Tien Nguyen, program manager, Office of Fuels Development, U.S. Department of Energy, August 4, 1999.
2. AFPA (American Forest and Paper Association). 1994. Agenda 2020: A Technology Vision and Research Agenda for America's Forest, Wood, and Paper Industry. Atlanta, Ga.: American Forest and Paper Association.
3. APAC (Agricultural Policy Analysis Center). 1999. The POLYSIS Modeling Framework Overview. Available on line at: http:/apasweb.ag.utk.edu/Projects_Research/POLYSIS/polysys.html
4. Brown, M.A., M.D. Levine, J.P. Romm, A.H. Rosenfeld, and J.G. Koomey. 1998. Engineering-economic studies of energy technologies to reduce greenhouse gas emissions: opportunities and challenges. Annual Review of Energy and Environment 23: 287-386.
5. Christian, D.P., G.J. Niemi, J.M. Hanoski, and P. Collins. 1994. Perspectives on biomass energy tree plantations and changes in habitat for biological organisms. Biomass and Bioenergy 6: 31-39.
6. Dale, B.E. 1983. Biomass refining: protein and ethanol from alfalfa. Industrial and Engineering Chemistry Product Research and Development 22: 466-472.
7. De la Rosa, L.B., B.E. Dale, S.T. Reshamwala, V.M. Latimer, E.D. Stuart, and B.T. Shawky. 1994. An integrated process for protein and ethanol from coastal Bermuda grass. Applied Biochemistry and Biotechnology 45/46: 483-497.

BOT 405: PRACTICALS BASED ON BOT 401 &BOT 402

1.Study of the following through habit sketches temporary preparations, permanent slides, photographs specimens products microchemical tests etc. to bring out the economic importance: **Cereals**: Wheat, Rice, Millets and Pseudo cereals; **Legumes**: Soyabean, groundnut and gram, **Fruits**: mango, citrus and papaya; **Sugars and starches**: sugarcane, potato, cassava; **Spices**: black pepper, coriander, fennel; **Beverages**: tea, coffee, cocoa; **Oils and Fats**: Coconut, mustard and linseed **Essential-oil yielding plants**: Rosa, *Cymbopogon, Vetiveria, Santalum*and *Eucalyptus*; **Fiber-yielding plants**: *Gossypium, Corchorus,* jute; **Woods**: *Tectona, Pinus***Rubber***: Heveabrasiliensis*; **Drug yielding plants:** *Cinchona, Digitalis, Rauvolfia, Papaver, Cannabis*; **Fumitory plants**: Tobacco Each student should submit a theoretical project on any one of the topic pertaining to the course content. Some of the suggested topics for this purpose are: Biofuels; Biocides; Newer drug plants; Germplasm conservation; IPR, MTA; Heterosis; Selection methods of breeding; Conventional and non conventional plant breeding methods, GM crops, Quarantine Practices in a botanical conservation.

2. Determination of colony forming units (CFUs) using haemocytometer, dimensions of microbes using ocular- and stage-micrometer. 3. Differential staining of bacteria using Gram-stain; Endospore staining using Malachite Green; Methods for measurement of bacterial growth. 4. Isolation and estimation of bacterial proteins; Study of amylase and protease activity in bacteria. 5. Estimation of phosphate solubilizing capacity of microorganisms; Characterization of Plant Growth Promoting Rhizobacteria – Production of ammonia, IAA, siderophores, HCN, antibiotics, antifungal metabolites. 6. Isolation of *Rhizobium* from root nodules. 7. Isolation, identification and enumeration of AM fungal spores from soil. 8. Isolation of bacterial nucleic acids from soil to study microbial diversity of unculturables.

BOT 406: BIOPROCESS ENGINEERING

UNIT I

An introduction to fermentation processes. Isolation, preservation and improvement of industrially important microorganisms.

UNIT II

Media for industrial fermentation- typical media, media formulation, water, energy and carbon sources, nitrogen sources, minerals, vitamin sources, nutrient recycle buffers.

UNIT III

Sterilization of air and media: Media sterilization, batch and continuous media sterilization processes, sterilization of fermenter Design of fermenter- Basic functions of a fermenter, construction, aeration and agitation, baffles

UNIT IV

Aeration and agitation: The oxygen requirements of industrial fermentation processes

UNIT V

Instrumentation and control: Control systems, manual, automatic, methods of measurements of process variables, measurement and control of dissolved oxygen

Suggested readings:

1. Wilson, K. and Walker, J., 2000, Practical Biochemistry: principles & techniques. Cambridge University Press.ISBN 0521799651.

2. Buchanan, B., Gruissem, W., & Jones, R.L., 2002, Biochemistry and Molecular Biology of Plants. American Society of PlantBiologists, USA.

3. Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M and Richard, L. 2008. Molecular Biology of the Gene. Pearson Education Inc.

4. Nelson, D .L. and Cox, M.M., 2008, Lehninger Principles of Biochemistry, W. H. Freeman & Co, New York, USA

5. Murray, R, Murray, RK, Bender, D, Gotham, KM, Kennelly, PJ, Rodwell, V and Weil, PA. 2012. Harper's Illustrated Biochemistry McGraw Hill

6. Wilhelm Gruissem, Russell L.Jones, 2000, Biochemistry and molecular biology of plants. American Society of Plant Physiologists,

7. .Berg, J.M., Tymoczko, J.L. &Stryer, L. 2011, Biochemistry, Freeman & Co., New York, USA.

8. Weil, J.H., 1990, General Biochemistry, Wiley Eastern Limited, New Age International Limited. New Delhi.

9. Lea P.J. and Leegood R.C., 1999, Plant Biochemistry & Molecular Biology, John Wiley & Sons, NewYork.

BOT 407: HERBAL MEDICINE

UNIT I

Medicinal plant research scenario in India. Diagnostic features, bioactive molecules and therapeutic value of some common medicinal plants.

UNIT II

Commercial cultivation of medicinal plants. Conservation of medicinal plants

UNIT III

Neutraceuticals and medicinal food

UNIT IV

Bioprospecting, biopiracy and protection of traditional medicinal knowledge (IPR)

UNIT V

Standardisation of herbal drugs

Suggested readings:

1. David Hoffmann – *Medical Herbalism – The Science and Practice of Herbal Medicine,* 2003, Healing Arts Press, Vermont.

2. Andrew Chevalier – *The Encyclopedia of Medicinal Plants: A Practical Reference Guide to over 550 Key Herbs and Their Medicinal Uses*, 1996, Dorling Kingsley Publishing
3. Anthony Godfrey, Paul Saunders, Kerry Barlow, Matt Gowan, *Principles and Practices of Naturopathic Botanical Medicine: Volume 1: 2012*
4. Matthew Wood, *The Earthwise Herbal: A Complete Guide to Old World Medicinal Plants*, and *The Earthwise Herbal: A Complete Guide to New World Medicinal Plants*, 2008, North Atlantic Books
5. Thomas Bartram – *The Encyclopedia of Herbal Medicine*, 1995, Grace Publishing.

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