

DEPARTMENT OF BOTANY M.SC SYLLABUS

B0T-PG-CT101	Phycology, Bryology, Pteridology & Gymnosperms	Credits 4
B0T-PG-CT102	Angiosperm Taxonomy, Anatomy & Embryology	4
B0T-PG-CT103	Cytogenetics, Plant Breeding & Evolution	4
B0T-PG-CP104	Taxonomy, Embryology, Bryology, Pteridology, Gymnosperms Lab	2
B0T-PG-CP105	Anatomy, Cytogenetics, Plant Breeding & Evolution Lab	2
B0T-PG-CT201	Biochemistry, Physiology & Molecular Biology	4
*B0T-PG-OT202	Ecology & Biodiversity	4
B0T-PG-CT203	Microbiology & Plant Pathology	4
B0T-PG-CP204	Biochemistry, Physiology and Molecular Biology Lab	2
B0T-PG-CP205	Ecology, Microbio. & Plant Path. Lab	2
*B0T-PG-OT301	Techniques and Instrumentation in Biological sciences.	4
B0T-PG-CT302	Biostatistics, Bioinformatics and Environmental Sciences	4
B0T-PG-CP303	Bioinformatics & Computer Applications Lab	2
B0T-PG-ET304	Taxonomy of Lower Group of Plants	4
B0T-PG-ET305	Introduction to Ethnobotany & Eastern Himalayan Bioresource	
B0T-PG-ET306	Introduction to Plant diseases	
B0T-PG-ET307	Plant Physiology	
B0T-PG-ET308	Intro. to Plant Tiss. Cult. & Gen. Engg.	
B0T-PG-EP309	Lower Plant Taxonomy Lab	2
B0T-PG-EP310	Secondary Metabolite analysis lab	
B0T-PG-EP311	Plant Pathology Lab	
B0T-PG-EP312	Plant Physiology Lab	
B0T-PG-EP313	Plant Cell and Tissue culture Lab	
B0T-PG-ET401	Fundamental & Advanced Systematics	4
B0T-PG-ET402	Plant Secondary Metabolites & Analysis	4

BOT-PG-ET403	Crop Protection & Management	4
BOT-PG-ET404	Plant Metabolism	4
BOT-PG-ET405	Molecular Genetics, Genomics & Proteomics	4
BOT-PG-ET406	Biodiversity Conservation: Legal & Ethical Framework	4
BOT-PG-ET407	QC, QR and Clinical Research of Herbal drugs	4
BOT-PG-ET408	Seed testing and Plant Quarantine	4
BOT-PG-ET409	Biochemistry.	4
BOT-PG-ET410	Biosafety, Bioethics and IPR	4
BOT-PG-EP411	Advanced Taxonomy & Angiosp. Systematics Lab	2
BOT-PG-EP412	Upstream & Downstream Processing Lab	2
BOT-PG-EP413	Seed Technology Lab	2
BOT-PG-EP414	Biochemistry Lab	2
BOT-PG-EP415	Molecular Biology & Genetic Engg. Lab	2
BOT-PG-BT416	**Botanical Tour (Mandatory) & Submission of Herbarium	4
BOT-PG-DV417	Dissertation + Viva-Voce	4

*Open Theory subjects. Can be opted by students from any other departmental as well.

**Botanical Tour of 12 days duration will be conducted during the winter vacation break between 3rd & 4th Semester. It is compulsory for all PG students of Botany. Students will have to submit at least 25 & above Herbarium sheets & tour report which will be used for evaluation purpose.

Abbreviations:

CT - Core Theory
 CP - Core Practical
 OT - Open Theory
 ET - Elective Theory
 EP - Elective Practical

SEMESTER-I
BOT-PG-CT101
PHYCOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS

Unit I: PHYCOLOGY

Pigments and classification in algae. Comparative account of algal pigments, reserve food, flagellation, chloroplast and eyespots, taxonomic importance. Prokaryotic and Eukaryotic algae. Economic importance of algae.

Unit II: BRYOLOGY

General character and Classification of Bryophytes. Comparative study of gametophytes and sporophytes of major classes (Hepaticopsida, Anthocerotopsida and bryopsida). Alternation of generations in life cycle, sporophytes evolution. Economic importance of bryophytes.

Unit III: PTERIDOLOGY

Classification of Pteridophytes. Structure and reproduction in ferns, Telome theory, Stelar evolution, Heterospory and seed habit. Study of Fossil pteridophytes: Rhynia, calamites, Lepidodendron, Economic importance of pteridophytes.

Unit IV: GYMNOSPERMS

Classification of gymnosperms. Comparative study of vegetative, anatomical and reproductive structures of cycadophyta, coniferophyta, Gnetophyta. Evolutionary trends and phylogenetic relationship among various groups of gymnosperms. Economic importance of gymnosperms.

References:

Algae

1. Kumar, H.D. and H. N. Singh (1971). Textbook of Algae
2. Sharma, O.P. (1986) Textbook of Algae
3. Pandey, B. P. (1994) Textbook of Botany – Algae
- 4 Fritsch, F. E. (1965) Structure and Reproduction of Algae
7. Chapman, V.J. and D. J. Chapman (1965). The Algae.
9. An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press
10. Morris, J. 1986. An Introduction to the Algae. Cambridge University Press, U.K.

Fungi

1. Alexopoulos, C.J. and C. W. Mims (1996): Introductory Mycology
2. Sharma, O.O. (1989): Textbook of Fungi
3. Ainsworth, G. G. and A.S. Sussman: The Fungi Vols. I, II, III, IV- A and IV-B
4. Bessey, E. A. (1967): Morphology and Taxonomy of Fungi
5. Gangulee, H.S. and A. K. Kar (1992): College Botany Vol. I
6. Dayal (1995): Aquatic Fungi of India

Bryophytes

1. Cavers, R. (1964): Inter-relationship of Bryophytes
2. Parihar, N. S. (1959): An introduction to Embryophyta. Vol. I – Bryophyta
3. Ram Udar (1976): Bryology in India

4. Watson, E.V, (1964): The Structure and life of Bryopytes
5. Vashista, B.R. (1996): Botany for degree students - Bryophyta
6. Chopra, R. N. and P. K. Kumra (1988): Biology of Bryophytes.
7. Parihar, N.S. 1991. Bryophytes. Central Book Depot, Allahabad
8. Puri, P. 1980. Bryophytes. Atma Ram & Sons, New Delhi.

Pteridophytes and gymnosperms

1. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
2. Sporne, K.R. 1991. The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd
3. Sporne, K.R. The Morphology of Gymnosperme. B.I. Publications, New Delhi.
4. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age Int. Pvt. Ltd., New Delhi.
5. Vashishta, B.R. (1996) - Botany for degree students – Pteridophytes
6. Trivedi, A. N. (2002) - Advances in Pteridology

BOT-PG-CT-102

ANGIOSPERM TAXONOMY, ANATOMY & EMBRYOLOGY

Unit I: ANGIOSPERM TAXONOMY

Systems of angiosperm classification (Artificial, natural and phylogenetic system of classification), merits and demerits of major systems of classification. Principles of Taxonomy: Aims, Objective and Scope; International Code of Botanical Nomenclature: history, principles and rules; Taxonomic hierarchy, family, genus, species and other categories; Diagnostic characters of some selected families: Elementary idea about primitive and advance *taxa*

Unit II: SYSTEMATICS IN PRACTICE

Taxonomic approach of plant collection and herbarium preparation. Botanical garden, National parks and its importance and role, herbaria in India; Botanical Survey of India; its organization and role. Digital herbarium and database. Principles of conservation, *in situ* & *ex situ* conservation

Unit III: PLANT EMBRYOLOGY

Introduction to plant Embryology: Male gametophyte, structure of anther, microsporogenesis, role of tapetum, Pollen development, male sterility; Pollen germination, pollen tube growth and guidance; pollen allergy; Female gametophyte: ovule development, megasporogenesis; Organization of the embryosac, structure of the embryo sac cells. Pollination mechanisms and vectors, Pollen pistil interaction and fertilization; structure of pistils; pollen-stigma interaction sporophytic and gametophytic incompatibility, double fertilization. Endosperm development, polyembryony; apomixes, *in vitro* fertilization, Anther, Pollen and embryo culture.

Unit IV: PLANT ANATOMY

Anatomy in relation to taxonomy, nodal anatomy, the node-internode transition, formation of leaf and branch traces. Wood histology, growth rings, tracheids, vessels and wood rays, longitudinal parenchyma and its arrangement, grain and texture, knots, formation of resin cavities and tyloses, techniques and methods in wood technology. Anatomy of floral axis and the whorls, the leaf origin

of carpel, evidences from anatomy of essential and accessory whorls, types and distribution of laticifers and lenticels, anatomy in relation to their physiological roles. Anatomy of leaf in relation to photosynthesis and transpiration, modification of the root stem and leaf anatomy in relation to habit and habitat with special reference to aquatics, nitrogen fixers, epiphytes, xerophytes, parasites and mycorrhiza.

References

1. Bhojwani, S.S. and Bhatnagar, S.P (2000). The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.
2. Cutter, E.G. (1971). Plant anatomy: Experiment and Interpretation, Part II, Organs Edward Arnold, London.
3. Davis, P.H. and Heywood, V.H. (1965). Principles of Angiosperm Taxonomy. D Van Nostrand Co., New York.
4. Eames, A.J. and MacDaniels, L.H. (1947). An Introduction to the Plant Anatomy (2nd Ed.), McGraw Book Comp., New York.
5. Fahn, A. (1982). Plant Anatomy (3 rd Ed.), Pergamon Press, Oxford.
6. Grant W.E. (Ed.) (1984) Plant Biosystematics, Academic Press, Toronto.
7. Johri, B.M. (ed.). Embryology of Angiosperms. Springer-Verlag, Heidelberg, Berlin.
8. Judd, W.S.; Campbell. C.S., Kellogg, E.A. and Stevens, P.F. (1999). Plant Systematics A phylogenetic Approach. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, U.S.
9. Lawrence, G.H.M. (1951). Taxonomy of vascular plants. The MacMillan Co., New York.
10. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper & Row Publicatons, USA.

BOT-PG-CT-103 CYTOGENETICS, PLANT BREEDING & EVOLUTION

Unit I: CELLULAR ORGANIZATION IN PLANTS

Ultra structure & organization of plant cells, molecular organization, cytoskeleton, cell division & differentiation, cell signaling & signaling pathways in plants.

Unit II: GENETIC BASIS OF REPRODUCTION

Inheritance- classical and modern perspectives, molecular basis. Chromatin organization, Chromosome structure and packaging of DNA, concept of gene, monogenic and polygenic inheritance.

Unit III: PLANT BREEDING & CROP IMPROVEMENT

Genetic variability, selection, hybridization, self and cross pollination, apomixes, domestication, back cross-technique and importance, heterosis breeding, wide hybridization, GXE interactions, cytoplasmic inheritance, molecular plant breeding, molecular marker systems & Importance, applications of plant breeding

Unit IV: EVOLUTION

Evolution – History of evolutionary thoughts. Mechanisms of evolution (natural selection, gene flow, mutation, genetic drift, and factors that influence population genetic structure). Origin and evolution of life - theories of evolution: Lamarkism, Darwinism and principles of Hugo de Vries.

Adaptation, co-evolution, speciation and extinction. Speciation and modes of speciation - sympatric vs allopatric. Population Genetics. Methods for studying plant evolution.

References

1. Gardner *et al.* 1991. Principles of Genetics, John Wiley & Sons Inc., 8th Edn., New York.
2. Chahal GS & Gosal SS 2002 Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches, CRC Press.
3. Jack Brown and Peter Caligari, 2008. Introduction to Plant Breeding, Blackwell Publ. UK.
4. George Acquaah, 2006, Principles of Plant Genetics and Breeding. Blackwell Publ. UK.
5. Karp, G. 1999. Cell and Molecular Biology: Concept and Experiments. John Wiley and Sons, Inc., USA.
6. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.
7. Sharma J.R 1994 Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.
8. Singh B.D 1996 Plant Breeding – Principles and methods. Kalyani Publications, Ludhiana.

BOT-PG-CP-104

TAXONOMY, EMBRYOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS LAB

- 1) Description of a specimen from representative (locally available) families.
- 2) Field trips within and nearby areas in the campus, compilation of field notes and preparation of herbarium sheets of such plants wild or cultivated that are abundant. Photography of the collected specimens and their habitat (if applicable)
- 3) Training in using floras and herbarium for identification of specimens described in the class.
- 4) Training in paraffin wax method for preparation of serial sections from fixation to mounting of permanent slides.
- 5) Staining of slides using single and double stains. Demonstration of slides showing embryological peculiarities (male and female gametophytes, endosperm, embryo)
- 6) Introduction to techniques in experimental embryology.
- 7) Morphological study (through section cutting and permanent slides) of representative members of bryophytes: *Marchantia*, *Porella*, *Anthoceros*, *Sphagnum*, *Funaria*, *Polytrichum*.
- 8) Observation of morphological, anatomical and reproductive structures of representative members of Pteridophytes – *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Gleichenia*, *Pteris*, *Marsilea*, *Ophioglossum*, *Isoetes*, *Osmunda* and *Azolla*.
- 9) Observation of morphological, anatomical (through C.S., RLS & TLS) and reproductive structure of gymnosperms – *Cycas*, *Cuppressus*, *Pinus*, *Araucaria*, *Ephedra*, *Gnetum*.
- 10) Observation of slides and specimen of fossil gymnosperms

References

- a) Parihar, N.S (1991). Bryophytes. Central Book Depot, Allahabad.
- b) Parihar, N.S. (1996). The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
- c) Puri, P. (1980). Bryophytes. Atma Ram & Sons, New Delhi.
- d) Sporne, K.R. (1991). The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd.

- e) Sporne, K.R. The Morphology of Gymnosperme. B.I. Publications, New Delhi.
- f) Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms, New Age Int. Pvt. Ltd., New Delhi.

BOT-PG-CP-105

ANATOMY, CYTOGENETICS, PLANT BREEDING & EVOLUTION LAB

- 1) Smear preparations in *Allium cepa*; Study of Mitosis using onion root tip.
- 2) Meiotic analysis in plants (*Allium cepa*).
- 3) Meiotic studies in structural hybrids (*Rhoeo, Setcreatia Cynotis*).
- 4) Induction of polyploidy using Colchicine.
- 5) Special type of chromosome in *Drosophila melanogaster*.
- 6) Practice of hybridization techniques in self and cross pollinated plants.
- 7) Biometrical techniques in Plant breeding – ANOVA.
- 8) Comparative anatomy of monocotyledon and dicotyledon root, stem and leaf.
- 9) Anatomical basis of identification C3 & C4 sub types in grasses.
- 10) Anatomy of lenticels and periderm in plants.
- 11) Study of microsporangium and microsporogenesis.
- 12) Study of megasporangium and embryo sac development.

References

- a) Eames AJ & Mac Daniels LH. 1947. Introduction to Plant anatomy, McGraw Hill, New York.
- b) Esau K. 1985. Plant anatomy, 2nd Edition, Wiley Eastern Limited, New Delhi.
- c) Metcalf C. R. and Chalk L. 1950. Anatomy of Dicots Vol. I & II, London Press, Oxford.
- d) Romberger J. A., Hejnowicz Z. and Hill J. F. 1993. Plant Structure: Function and Development, Springer-Verlag.
- e) Jahier, J. Techniques of plant cytogenetics. Oxford and IBH Publishing.
- g) Roy Darbeshwar 2000, Plant breeding analysis and exploitation of variance. Narosa Pub., New Delhi.
- h) Sharma J. R. 1998 Statistical and Biometrical techniques in Plant Breeding New Age Intl. Publ. Publishers New Delhi.
- i) Sharma, A. K. and Sharma, A. 1980. Chromosome techniques- Theory and practice. Butterworth and Co. (Publishers) Ltd., London.
- k) Sharma, J. R. Principles and practice of Plant breeding. Tata McGraw Hill Publ., New Delhi.
- l) Singh, B. D. 2000. Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana

SEMESTER-II

BOT-PG-CT-201

BIOCHEMISTRY, PHYSIOLOGY & MOLECULAR BIOLOGY

Unit I: PLANT BIOCHEMISTRY

Physical and chemical properties of water. Acid base chemistry, buffers, chemical bonding and bond energy in bimolecules. Nucleotides and nucleic acids: Structure; chemical and physical

properties; Chemical synthesis. Amino acids: classification, properties, peptide bonds. Protein: Structures, Sequence, Conformation. Carbohydrates: Mo, di and polysaccharides. Lipids: classification, chemical structures and physical properties. Enzymes: Nature and classification of enzymes. Enzymes kinetics, bisubstrate reaction.

Unit II: PLANT PHYSIOLOGY

Bioenergetics: First and second law of thermodynamics. Study of glycolysis and citric acid cycle. Oxidative phosphorylation and photophosphorylation. Electron transfer reaction in mitochondria, light absorption by chloroplast pigments. Biological nitrogen fixation; Biology of Nodule formation; Mechanism of nitrate uptake, reduction and ammonium assimilation; Sulphate uptake and assimilation. Biosynthesis of purine & pyrimidine ribonucleotides. Purine degradation and disorders of purine metabolism.

Unit III: BIOSYNTHESIS OF NUCLEIC ACIDS & TRANSPOSONS

DNA replication: Molecular mechanism. Replication of RNA genomes. Mobile genetic elements - IS elements and transposons in maize and bacteria. Transposition, phenotypic and genotypic effects; evolutionary significance. Homologous recombination, transposition and site-specific recombination. Extra-chromosomal (maternal) inheritance: inheritance of mitochondrial and chloroplast genes.

Unit IV: PROTEIN BIOSYNTHESIS & REGULATION

Transcription: mechanism in prokaryotes & Eukaryotes – RNA-Polymerases, initiation, elongation and termination. Post transcriptional modifications. Translation - mRNA organization, the genetic code, translation machinery, deciphering the code, translation in *E. coli* and differences in eukaryotes. Post translation processing - chaperones and protein targeting. Principles of gene regulation, the *lac* operon and *trp* operon. Regulation in Eukaryotes.

References

1. Watson and others – 2004: Molecular Biology of the gene (V); pearsons Educatias, Inc India
2. P.C. Turner and others – 2002: Molecular Biology (II); Viva Books, Pvt. Ltd., New Delhi.
3. W. Ream and KG. Field – 1999: Molecular Biology Techniques; Academic Press, London.
4. Brace Alberts et al – 1983: Molecular Biology of the cell; Garland Publ. Inc., New York.
5. Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
7. Davies P J. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
8. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H.
9. Freeman and Company, New York, USA.

BOT-PG-OT-202 ECOLOGY AND BIODIVERSITY

Unit I: ECOLOGY AND POPULATION DYNAMICS

Ecology definition, Types of ecology, History and scope of ecology. Population Concepts: Population Characteristics, Population growth, Carrying capacity, Population regulation, r and k selection.

Unit II: ECOLOGICAL SUCCESSION AND ECOSYSTEM CONCEPT

Ecological Succession: Mechanism of Ecological Succession, Changes in ecosystem during succession, Climax concept. Ecosystem Structure and Function: Biotic and abiotic components of ecosystem, Energy flow, Biogeochemical cycling, Ecosystems Nutrient cycling, Litterfall and decomposition dynamics, Ecosystem stability.

Unit III: CLIMATE CHANGE AND CARBON TRADE

Climate change, greenhouse gases, Global warming ozone layer depletion, Carbon sequestration, Carbon trading, Consequences of climate change. Introduction to Remote sensing, GPS, GIS and its application.

Unit IV: BIODIVERSITY AND CONSERVATION

Biodiversity: Concepts and levels, Global and regional pattern of biodiversity, Hotspots of biodiversity, threats to biodiversity (IUCN categories) Biodiversity conservation (Regional and International).

References:

1. Misra, R. (1968). Ecology Work Book. Oxford & IBH, New Delhi
2. Odum, E.P. (1971). Fundamentals of Ecology. Saunders, Philadelphia
3. Odum, E.P. (1983). Basic Ecology. Saunders, Philadelphia
4. Singh, J.S., Singh S.P., Gupta S.R. (2006). Ecology Environment and Resource conservation. Anamaya Publishers, New Delhi
5. P.D. Sharma (2001) Ecology and environment. Rastogi Publication, Meerut

BOT-PG-CT-203 MYCOLOGY, MICROBIOLOGY & PLANT PATHOLOGY

Unit I: INTRODUCTION TO MICROBIOLOGY

General characteristics of microorganisms. Study about scope, branches and history of Microbiology. Nomenclature, classification, properties and structure of bacteria and viruses. Pathogenic types of toxins, nonspecific and specific defense mechanisms. Culture techniques: Bacteria; anaerobic, aerobic culture media, growth curve, growth kinetics, batch, continuous culture, growth measurements. Pure culture techniques, preservation methods. Culture techniques for viruses and fungi.

Unit II: MYCOLOGY

Introduction, scope and general principles of fungal classification. Study of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Dueteromycotina with representative classes. Lichens: Thallus structure, reproduction and economic importance. Economic importance of fungi.

Unit III: PLANT PATHOLOGY

Historical and developmental aspects of Plant pathology. Mode of infection and role of enzymes and toxins in plant disease. Defense mechanisms of plants against infection: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds.

Unit IV: PLANT DISEASES

Study of Plant diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma like organisms: Wart disease of potato, blight of *Colocasia*, downy mildew of cucurbits, peach leaf curl, ergot of bajra, smut of sugarcane, Karnal bunt of wheat, linseed rust, Tikka disease of groundnut, red rot of sugarcane, Panama disease (Fusarium wilt) of banana, bacterial blight of rice, leaf curl of tomato, yellow vein mosaic of bhindi, mosaic of sugarcane, potato spindle tuber mosaic, ear cockles of wheat, grassy shoot of sugarcane, phylloidy of sesamum, Citrus greening.

References:

1. R.C. Dubey and Maheshwari, D.K.2002. A Text book of Microbiology, S.C. Chand and Company, Ltd. Ramnagar, New Delhi.
2. S.B.Sullia and Shanthara. S.1998. General Microbiology. Oxford and IBH publishing Co.Pvt.Ltd. New Delhi.
3. Sharma, P.D.1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
4. Ananthnarayan, R and Jayaram Panikar, C.K. 1986. Text book of Microbiology. Orient Longman ltd. New Delhi.
5. Allas, R.M. Microbiology: Fundamentals and Applications, Macmillan Publishing co. New York.
6. Brook, T.D. Smith, D.W and Madigan, M.T. 1984. Biology of Microorganisms, 4th ed. Eaglewood Cliffts. N.J. Prentice-Hall. New Delhi.
7. Claus, William, G.1989. Understanding microbes. A laboratory text book for Microbiology. W.H. Freeman and Company, New York.
8. Jayaraman, J. 1985. Laboratory Manual of Biochemistry, Wiley Eastern Limited. New Delhi.
9. Ketchum, PA. 1988. Microbiology, concepts and applications. John Wiley and Sons. New York.
10. Stainer, Roger, Y. Ingrahan, John, L. Wheelis, Mark, L and Painter, Page, R. 1990. Microbial World 5th edition. Prentice-Hall India, Pvt. Ltd. New Delhi.
11. Schlegel, H.G.1986. General Microbiology. Cambridge University Press. London.
12. Sharma, R. 2006. Text book of Microbiology. Mittal Publications. New Delhi.

BOT-PG-CP-204

PLANT BIOCHEMISTRY, PHYSIOLOGY AND MOLECULAR BIOLOGY LAB

1. Determination of Osmotic pressure of plant tissue
2. Estimation of total Chlorophyll from leaves of different chronological ages
3. Study and separation of leaf Anthocyanin by thin layer chromatography
4. Study on Seed viability by Tetrazolium test [TZ] test
5. Effect of plant hormone on water uptake
6. Preparation of standard curve of a known protein (BSA) and estimation of an unknown protein by Lowry's method

7. Extraction and estimation of Peroxidase from plant sample.
8. Extraction and estimation of free amino acid from plant sample
9. Isolation, purification and quantification of DNA from leaf tissues
10. Agarose gel electrophoresis for separation of DNA.
11. PAGE for separation of Protein mixtures.
12. Polymerase Chain Reaction

References:

- a) Sadasivam S and Manickam A. 2010. Biochemical methods, New Age International Publishers, New Delhi
- b) Plummer D T. 1998. An introduction to practical biochemistry, Tata McGraw Hill
- c) Bewly J D and Black E. 1980. Seeds: physiology of development and germination, Plenum Publishing Corporation.
- d) Moore T C. Research experience in plant physiology-a laboratory manual. Springer-Verlag

BOT-PG-CP-205
ECOLOGY, MICROBIOLOGY & PLANT PATHOLOGY LAB

ECOLOGY LAB

1. Determination of IVI.
2. Study of the Litter production.
3. Determination of association index.
4. Ecological report of an area.

PLANT PATHOLOGY LAB

1. Study of Symptoms and Causes of the following diseases related to local crops: Large Cardamom, Ginger, banana, Bacterial leaf blight of rice, bacterial leaf streak of rice, stem rot of rice, any other locally relevant crops.
2. Study of the specimens of the following diseases: Yellow smut of wheat; bacterial rot of wheat ears; Late blight of potato, bacterial brown rot of potato, soft rot of potato, Bean mosaic disease.

MICROBIOLOGY LAB

1. Culture media preparation: PDA, CZA, Nutrient media, preparation of agar slants, method of inoculum transfer.
2. Different types of bacterial staining - Simple, Gram's, Capsular staining, Endospore staining Negative staining
3. Procedure for quantitative estimation of Microorganisms -Total count (haemocytometer) Viable count (Plate count)
4. Method for isolation and enumeration (CFU) of microorganisms in soil by serial dilution.
5. Microbial Examination by Petriplate expose method.
6. Pure culture technique of bacteria

References

- a) Mehrotra, R.S, and Ashok Aggarwal, 2004. Plant pathology

- b) Michael, J Pelczer, E.C.S. Chan, Noel R. Krieg, 1993. Microbiology concepts and applications, —McGraw Hill Inc, New York.
- c) Moore Landecker, E., 1971. Fundamentals of Fungi. Prentice Hall Publication.
- d) Mukta Bhargava, 2003. The latest portfolio of theory and practice in Fungi, A.S Saini Dominant publications.
- e) Sambamurthy A.V. S.S. 2006. A Textbook of Plant Pathology. I.K. International Pvt. Ltd., New Delhi.
- f) Ananthanarayanan, R. and CKJ. Paniker, 2004. Textbook of Microbiology. Orient Longman.
- g) Dubey, R.C. and D.K. Maheswari, 2007. A Textbook of Microbiology, S. Chand & Company.
- h) Powar, C.B and Daginawala 1991. General Microbiology Val-I and Vol-II Himalaya publishing.

SEMESTER-III

BOT-PG-OT-301

TECHNIQUES & INSTRUMENTATION IN BIOLOGICAL SCIENCES

Unit I: GLP, BUFFERS AND SOLUTIONS

Laboratory practices: General safety measures, Chemical hazards, Physical hazards, Biological hazards, waste disposal. spillage and waste disposal, disposal of carcinogenic chemical and radioactive wastes, first aid. pH and buffer solutions: SI units; Molarity and moles; Acids and base; Hydrogen ion concentration and pH, Dissociation of acids and bases; Buffer solutions.

Unit II: CHROMATOGRAPHY & MICROSCOPY

Chromatography Techniques: General Principles and techniques, principle, Application and material of column chromatography; Thin layer chromatography; Paper chromatography; Adsorption chromatography; Partition chromatography; (liquid-liquid chromatography); Gas-liquid chromatography; Ion exchange chromatography; Exclusion chromatography; Affinity chromatography; High performance liquid chromatography. Microscopy: Principles and applications of various of Light and Electron microscopy. Dark field, Bright Field, Phase contrast, confocal, fluorescence, scanning & transmission electron microscopy, Atomic Force Microscopy Tissue Processing for Light and Electron Microscopy Micrometry.

Unit III: ELECTROPHORESIS & SPECTRPHOTOMETRY

Electrophoresis Techniques: General principles; Principle, material and application of Isoelectric focusing, SDS-PAGE; Isotachophoresis; Low and high voltage electrophoresis; Preparative Electrophoresis; Detection, recovery and estimation. Spectroscopic Techniques; General principles; Basic law of light absorption; Types of spectra and their biological usefulness. Principle, application and instrumentation of UV-VIS spectrophotometry; IR spectrophotometry; CD (circular dichoresim) spectrophotometry; Spectrofluorometry; Luminometry; Atomic/flame spectrophotometry; Mass spectrometry; ESR (electron spin resonance) and NMR (nuclear spin resonance).

Unit IV: RADIOBIOLOGY & CENTRIFUGATION

Radiobiology: The nature of radioactivity; Atomic structure, stability and radiation; Isotopes; Types of radioactive decay; Detection and measurement of radioactivity; Geiger-muller counter; Scintillation counter; Applications of radioisotopes in biological sciences; Safety aspects of use of radioisotopes. Centrifugation Techniques: Basic principles of sedimentation; Centrifuge and their use; Small bench centrifuge; High speed refrigerated centrifuge; Continuous flow centrifuge; Preparative ultracentrifuges; Analytical ultracentrifuges; Density gradient centrifugation; Preparative centrifugation; Design and care of rotors, safety aspects in the use of centrifuges.

References

1. Keith Wilson & John Walker (Ed.) (2000): Practical Biochemistry - Principles & Techniques. Cambridge University Press.
2. Keith Wilson and John Walker (Ed). (2006) Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Hawcroft D.M. (1996): Electrophoresis - The Basics. IRL Press, Oxford.
4. Robards K., Haddad P.R., & Jackson P.E. (1994): Principles and Practice of Modern Chromatographic Methods. Academic Press, London.
5. E.D.P. De. Robertis & E.M.F. De Robertis Jr. (2001): Cell and Molecular Biology (8th edn.) Lippincott Williams & Wilkins, London.
6. Skoogs, Holler and Nieman, (2006) Principles of Instrumental Analysis, Thomson books.
7. Prakash Singh Bisen. Introduction to Instrumentation in Life Sciences. 2012. CRC press. ISBN 9781466512405
8. Ghoshal Sabari & Srivastava A K. Bioanalytical Techniques & Instrumentation. 2009.
9. Ghosha, Sabari, Srivastava A K. Fundamentals of Bioanalytical Techniques and Instrumentation. PHI learning Pvt. Ltd., New Delhi

BOT-PG-CT-302

BIostatistics, Bioinformatics and Environ. Biology

Unit I: INTRODUCTORY BIostatistics

Principle and practice of statistical methods in biological research. Populations and samples; Data, graphical presentation of data – frequency distribution, Mean, variance and standard deviation, Sampling distributions, coefficient of variation and standard error, t distribution, confidence level, Hypothesis testing and estimation, type I and type II errors, Probability distribution, Binomial and Poisson distribution, Non-parametric tests.

Unit II: REGRESSION AND CORRELATION

Experimental designs - completely randomised, randomised block and factorial experimental designs. Tests of statistical significance – Hypothesis testing for a single population mean, difference between two population means, paired comparison. Scatter diagram, simple linear regression and non-linear regression, correlation and correlation coefficient and application. One way analysis of variance, two – way analysis of variance and multivariate analysis of variance.

Unit III: INTRODUCTION TO BIOinformatics

Introduction to databases and retrieving information from databases: Databases; Molecular tools in protein and nucleotide sequence analysis; origin of new genes and Proteins, gene duplication and

divergence; Sequence similarities: Pairwise comparison of DNA and protein sequences, dynamic programming algorithms, FASTA and BLAST. Multiple sequence alignments, progressive methods, iterative methods, localized alignments; Determining phylogenetic relationships using DNA and protein sequences; Protein structure prediction, motifs and domains.

Unit IV: ENVIRONMENTAL BIOLOGY

Structure and composition of Atmosphere. Chemicals in Environment: Air - Chemical composition of air, ambient air quality standards. Natural and anthropogenic sources of pollution. Primary and secondary pollutants. Water - Chemistry of water. Types, sources and effects of water pollutants. Water quality standards - Physico chemical and Biological. Soil-Structure and physico-chemical properties of soil. Soil pollution and control. Environmental toxicology: Toxic chemicals, bioaccumulation (xenobiotics), effects. Pesticides in water. Biochemical aspects of arsenic, Cadmium, Lead and Mercury. Environmental monitoring, management and conservation.

References:

1. Balaam L N, Fundamental of Biometry, George Allen and Unwin Ltd. London, 1972.
2. Bliss CI, Statistic in Biology Vol. I and II, McGraw-Hill. 1970.
3. Causton DR, A Biologist Mathematics, Edward Arnold (Publishers) Limited, London, 1977.
4. Daniel WW, Biostatistics, 7th edition, John Wiley and Sons, New York, 1995.
5. Krishnamurthy, K.V. 2004. An advanced textbook on Biodiversity Principles and Practice. Oxford and IBH Publishing Co. Pvt. Ltd.
6. Introduction to Bioinformatics by Attwood, T.K. & Parry-Smith, D.J., Delhi, Pearson Education (Singapore) Pvt. Ltd., 200 Lab Math – Adams, D.S. I.K. Internations Pvt Ltd, New Delhi, 2004.
7. Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989
8. Statistical methods in Agri.and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983
9. Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H. , John Wiley, New York, 2001
10. Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
11. Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003.
12. Bioinformatics and Molecular Evolution – Higgs PG and Attwood, TK 8. Blackwell Publishing, Oxford, 2005.

BOT-PG-CP-303

BIOINFORMATICS & COMPUTER APPLICATIONS LAB

1. Acquiring basic computer operation and internet browsing skills in windows & Linux Platforms
2. Acquiring basic word processing/data entry skills using popular packages as MS word and Excel
3. Acquiring graphic representation skills using Photoshop, Coral draw, Chem draw, MS Power point

4. Use of statistical packages such as SPSS, Biostat, Origina, MS Excel
5. Exploring NCBI database system, querying the PUBMED and GenBank databases
6. Pair-wise global alignments of protein and DNA sequences & interpretation of results
7. Database (homology) searches using BLAST and FASTA and interpretation of the results
8. Multiple sequence alignments of sets of sequences using web-based and stand-alone version of CLUSTALW. Interpretation of results.
9. Exploring and using the derived databases: PROSITE, PRINTS, BLOCKS, Pfam and Prodom for pattern searching, domain searches etc.
10. Structure prediction tools and homology modeling, Comparison of the performance of the different methods for various classes of proteins, Prediction of tertiary structures of proteins using Homology Modeling approach: SWISSMODEL, SWISS-PDB Viewer.

References

- a) Bioinformatics: A Practical Guide to the analysis of Genes and Proteins (2nd Ed.) by Baxevanis, A.D. & Ouellette, B., F. F., New York, John Wiley & Sons, Inc. Publications, 2002.
- b) Introduction to Bioinformatics by Attwood, T.K. & Parry-Smith, D.J., Delhi, Pearson Education (Singapore) Pvt. Ltd., 2001.
- c) Bioinformatics: Sequence and Genome Analysis by Mount, David, New York, Cold Spring Harbor Laboratory Press, 2004.
- d) Current Protocols in Bioinformatics by Baxevanis, A.D., Davison, D.B., Page, R. D. M. & Petsko, G.A., New York, John Wiley & Sons Inc., 2004.
- e) Structural Bioinformatics - Methods of biochemical Analysis V. 44 by Philip E. Bourne (Editor), Helge Weissig (Editor) New Jersey. Wiley-Liss, 2003.

ELECTIVE THEORY COURSES

BOT-PG-ET-304: TAXONOMY OF LOWER GROUP OF PLANTS

Unit I: FUNGI

Introduction and classification of Fungi, structure, economic importance, reproduction, life cycle and phylogeny of *Synchytrium*, *Aspergillus*, *Pencillium*, *Mucor*, *Rhizopus*, *Alternaria*, *Fusarium*, *Colletotrichum*, *Pestalozzia*, *Phytophthora*, *Morchella*, *Peziza*, *Ascobolus*, *Neurospora*, *Puccinia*, *Ustiligo*, *Polyporus*, *Agaricus*, *Lycoperdon*, *Cyathus* and *Helminthosporium*.

Unit II: ALGAE

Introduction and classification of algae, structure, economic importance, reproduction, life cycle, phylogeny of – *Ectocarpus*, *Batrachospermum*, *Vaucheria*, *Euglena*, *Microcystis*, *Anabaena*, *Rivularia*, *Hydrodictyon*, *Oedogonium*, *Ulva*, *Chara*, *Dictyota*, *Gracillaria* and *Polysiphonia*.

Unit III: BRYOPHYTES

Introduction and classification of bryophytes, structure, economic importance, reproduction, life cycle, phylogeny of *Marchantia*, *Riccia*, *Porella*, *Anthoceros*, *Sphagnum*, *Funaria*, *Polytrichum* and *Pogonatum*.

Unit IV: PTERIDOPHYTES & GYMNOSPERMS

Introduction and classification of Pteridophytes, morphological, anatomical and reproductive structures of *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Pteris*, *Marsilea*, *Osmunda* and *Azolla*. Origin and evolution of pteridophytes.

Introduction and classification of Gymnosperms, study of morphological, anatomical and reproductive structure of *Cycas*, *Pinus*, *Ephedra*, *Gnetum* and *Gingko*.

Origin and evolution of gymnosperms

References

1. Alexopoulos, C.J. Mims, C.W. and Blackwell, M. (1996). Introductory Mycology John Wiley & Sons.
2. Kumar, H. D. (1988). Introductory Phycology. Affiliated EastWest Press Ltd., New Delhi.
3. Morris, J (1986). An Introduction to the Algae. Cambridge University Press, U.K.
4. Round, F.E (1986). The Biology of Algae. Cambridge University Press, U.K.
5. Parihar, N.S (1991). Bryophytes. Central Book Depot, Allahabad.
6. Parihar, N.S (1996). The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
7. Puri, P (1980). Bryophytes. Atma Ram & Sons, New Delhi.
8. Sporne, K.R (1991). The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd.
9. Sporne, K.R. The Morphology of Gymnosperme. B.I. Publications, New Delhi.
10. Bhatnagar, S.P. and Moitra, A (1996). Gymnosperms, New Age Int. Pvt. Ltd., New Delhi.
11. Webster, J. (1985). An Introduction to Fungi. Cambridge Univ. Press.

BOT-PG-ET-305

INTRODUCTION TO ETHNOBOTANY & EASTERN HIMALAYAN BIORESOURCES

Unit I: TAXONOMY & ETHNOBOTANY

Ethnobotany: Introduction, history and evolution of concept and scope. Principles of taxonomy: aims, objective and scope. International Code of Botanical Nomenclature (ICBN): History, principles and rules. Taxonomic hierarchy, family, genus, species and other categories. Diagnostic characters of some selected families: Magnoliaceae, Ranunculaceae, Malvaceae, Rutaceae, Rosaceae, Umbelliferae, Compositae, Rubiaceae, Labiateae, Acanthaceae, Verbenaceae (dicots); Araceae, Liliaceae, Poaceae, Zingiberaceae, Orchidaceae (monocots).

Unit II: ETHNOBIOLOGY OF NE COMMUNITIES

Major and minor ethnic group in India and distribution. Tribal communities of the North Eastern states of India, settlement pattern, social institutions, livelihood, cultural and religious practices Shamanism and other belief systems, sacred grove and methods of biological resource conservation.

Unit III: EASTERN HIMALAYAN BIORESOURCES

Definition, concepts and types of biodiversity. Biodiversity scenario at global, national and regional level. Definition and demarcation of the Eastern Himalayas. Geographical background of Eastern Himalayas. Biodiversity hotspot zones and sub classification Bio-resources of Eastern Himalayas: medicinal and aromatic plants, wild edible plants spices and condiments, beverages, masticatories, important timber yielding and fire wood plants, important Non-Timber Forest Products (NTFP's), ethno-veterinary plants, bamboos, raw material for paper, gum, resin, tannins and dyes.

Unit IV: APPLIED ETHNOBOTANY

Role of Ethnobotany in drug discovery. Ayurvedic drug preparation and drug adulteration. Taxonomic epidermal characters and pharmacognostical studies to check adulteration. Problems and prospects of value addition applicable to plant resources. Scope for development of plant resources. Chemical composition of few medicinal and aromatic plants, extraction and uses pertaining to typical Indian formulation of drugs

References:

1. Cotton, C.M. (1997). Ethnobotany – Principles and applications. John Wiley and Sons – Chichester.
2. Das, T.S. (1986). Tribal life of North - Eastern India. Gian Publishing House.
3. Das, A.P. and Pandey, A.K. (2007). Advances in Ethnobotany. Bishen Singh and Mahendra Pal Singh, Dehradun.
4. Dhar, U. (1993). Himalayan Biodiversity: Conservation Strategies. Gyanodaya Prakashan.
5. Jain, S.K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur.
6. Jain, S.K. (1990). Contributions of Indian Ethnobotany. Scientific publishers, Jodhpur.
7. Jain and Mudgal. () Dictionary of Ethnobotany. Deep Publication, Delhi.
8. Kohil, Y.P. (1992). Recent advances in medicinal and aromatic spices crops. Today and Tomorrows Publisher.
9. Pusphanganthan *et al.* (1997). Conservation and Ecological Economics of Biodiversity.
10. Simpson, B.B. and Conner - Ogorzaly, M. (1986). Economic Botany: plants of our world. Mc Graw Hill.
11. Subba, T.B (1999). Politics of culture: a study of three Kirata communities in the eastern Himalayas. Orient Longman Limited, New Delhi.
12. Subba, T. B. and Ghosh, G. C. (2003). Anthropology of North-East India. Orient Longman Limited, New Delhi.

Unit I: PATHOGENS AND DISEASES

Plant diseases and pathogens, mode of infection, Role of enzymes and toxins in Plant diseases. Koch's postulates. Disease cycle. Defense mechanisms of plant diseases against infection. Structural defense and biochemical defense

Unit II: DISEASE FORECASTING AND EPIDEMICS

Disease diagnosis and assessment, Plant disease epidemics, Disease forecasting and its importance. Methods used in diseases forecasting.

Unit III: DISEASE TRANSMISSION AND ENVIRONMENTAL FACTORS

Transmission and spread of plant pathogens. Effect of environmental factors in disease development. Genetics of plant pathogen interaction. Molecular Plant pathology.

Unit IV: SYMPTOMATOLOGY, IDENTIFICATION, ETIOLOGY AND CONTROL MEASURES OF THE FOLLOWING PLANT DISEASES:

Potato wart, damping-off diseases, late blight of potato, white rust of crucifers, downy mildew of cucurbits, stem gall of coriander, peach leaf curl, powdery mildew pea, apple scab, ergot of rye, anthracnose disease of chilies, red rot of sugarcane, tikka disease of groundnut, blast of rice, false smut of rice, Karnal bunt of wheat, smut/smutts of wheat, barley, oats, bajra and sorghum, rust of wheat. Panama disease (Fusarium wilt) of banana, bacterial blight of rice, leaf Curl of tomato, yellow vein mosaic of bhindi, mosaic of sugarcane, Root Knot disease, ear Cockles of wheat grassy shoot of sugarcane, phylloidy of sesamum, Citrus greening.

References

1. Agrios, G.N. (1997). Plant Pathology. Academic Press, New York.
2. Ainsworth, G.C. Sparrow, F.K., and Sussman A.S. (1973). The Fungi- An Advanced Treatise. Vols. IV A. Academic Press, London.
3. Mehrotra, R.S. (1980). Plant Pathology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Mehrotra, R.S. and Aneja, K.R. (1990). An Introduction to Mycology. New Age International Publishers, New Delhi.
5. Webster, J. (1980). Introduction to Fungi. Cambridge University Press, Cambridge, London.
6. Vashista, B.R. and Sinha, A.K. (2008) Botany for degree students-Fungi. S. Chand and Company Ltd, New Delhi-pp 1-752.

BOT-PG-ET-307: ADVANCED PLANT PHYSIOLOGY

Unit I: PROGRAMMED CELL DEATH (PCD) AND SENESCENCE

Programmed Cell Death in Plants; Aerenchyma formation and HR; Reactive oxygen species and PCD; Apoptosis and PCD; Introduction to senescence; Pigment breakdown during senescence Nucleic acid degradation during senescence; Protein metabolism during senescence

Unit II: PLANT GROWTH REGULATORS

Concept of hormones as chemical messenger; Physiological effects and mechanism of action of brassinosteroids, jasmonic acid and salicylic acid; Role of hormones in defense against biotic and abiotic stress

Unit III: REPRODUCTIVE PHYSIOLOGY AND DEVELOPMENT

Flowering: floral induction, evocation and morphogenesis; Control of flowering: phytochrome, cryptochrome and Circadian rhythm; Fruit ripening: physiology of ripening, biochemical changes during ripening; Deposition of reserves during seed development; Germination: metabolic changes during seed germination

Unit IV: STRESS PHYSIOLOGY

Plant responses to abiotic stresses; Water deficit and its physiological consequences; Osmotic adjustment in response to drought and salinity; Drought tolerance mechanisms; Salinity stress and plant responses; Heat stress and low temperature stress

References:

1. Buchanan B.B, Gruissem W. and Jones R.L 2007. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists Maryland, USA.
2. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
3. Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA..
4. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA.
5. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
6. Salisbury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California, USA.
7. Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
8. Taiz L. and Zeiger E. 2010. Plant Physiology (5th Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.

BOT-PG-ET-308

TISSUE CULTURE AND GENETIC ENGINEERING OF PLANTS

Unit I: INTRODUCTION TO PTC

Importance of plant tissue culture and general techniques. Plant hormones and their functions in tissue culture. Single cell clones and callus culture. Suspension culture, meristem culture, anther and pollen culture.

Unit II: APPLICATIONS OF PTC

Ovary and ovule culture, embryo and endosperm culture, shoot-tip culture, micro propagation haploid culture. Organogenesis; Somatic embryogenesis; Transfer and establishment of whole

plants in soil, artificial seeds. Germplasm conservation: Cryopreservation, DNA banks and germplasm conservation.

Unit III: GENE CLONING TECHNIQUES

Construction of recombinant DNA molecules, vectors in rDNA, technology. Enzymes in Genetic Engg: Exonucleases and Restriction Endonucleases. Enzymes in modification. Methods of nucleic acid detection, polymerase chain reaction (PCR) and its applications, variations in PCR and applications, methods of nucleic acid hybridization Construction of libraries.

Unit IV: APPLICATIONS OF GENETIC ENGG.

Gene transfer techniques in plants. Application of genetic engineering, transgenic plants for insect, fungal, bacterial disease resistance, lignin, modification,, abiotic stress tolerance, production of useful products. Molecular farming. Techniques of gene mapping in plants. Marker-assisted selection and breeding for improvement.

References:

1. Butcher, D.N and D.S. Ingram, 1982. Plant tissue culture. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Butenko, R.G, 1985. Plant cell culture. MIR Publishers, Moscow.
3. Dixon, R.A, 1985. Plant cell culture: A practical approach. IRL press Oxford, London.
4. Dodds. J.H and L.N. Roberrtis (1985) Experiments in plant tissue culture, Cambridge University Press, New York.
5. Kalyan Kumar D.E.1992. Plant tissue culture, Agrobios, New Delhi.
6. Lindsley, K. 1992.Plant tissue culture manual. Kluwer Academic publishers.
7. Narayanaswamy, S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing company,Ltd. New Delhi.
8. Purohit, S.S and S.K. Mathur, 1993. Fundamentals of Biotechnology. Agrobotanical publishers, India.

ELECTIVE LABORATORY COURSES

BOT-PG-EP-309: LOWER GROUP TAXONOMY LAB

A. FUNGI

Identification of fungal cultures - *Rhizopus*, *Mucor*, *Aspergillus*, *Pencillium*, *Alternaria*, *Curvularia*, *Fusarium* and *Colletotrichum*.

B. ALGAE AND BRYOPHYTES

Morphological study of the following algae: *Ectocarpus*, *Batrachospermum*, *Vaucheria*, *Euglena*, *Microcystis*, *Anabaena*, *Rivularia*, *Hydrodictyon*, *Oedogonium*, *Ulva*, *Chara*, *Dictyota*, *Gracillaria* and *Polysiphonia*.

Morphological study of the following Bryophytes specimens: *Marchantia*, *Riccia*, *Porella*, *Anthoceros*, *Sphagnum*, *Funaria*, *Polytrichum* and *Pogonatum*.

C. PTERIDOPHYTES

Observation of morphological, anatomical and reproductive structures of the following: Pteridophytes *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Pteris*, *Marsilea*, *Osmunda* and *Azolla*. Observation and identification of slides and specimen of fossil pteridophytes.

D. GYMNOSPERMS

Observation of morphological, anatomical and reproductive structure of the following Gymnosperms: *Cycas*, *Pinus*, *Ephedra* and *Gnetum*.

Observation and identification of slides and specimen of fossil gymnosperms.

References:

- a) Alexopoulos, C.J. Mims, C.W. and Blackwell, M. (1996). Introductory Mycology John Wiley & Sons.
- b) Kumar, H. D. (1988). Introductory Phycology. Affiliated EastWest Press Ltd., New Delhi.
- c) Morris, J (1986). An Introduction to the Algae. Cambridge University Press, U.K.
- d) Round, F.E (1986). The Biology of Algae. Cambridge University Press, U.K.
- e) Parihar, N.S (1991). Bryophytes. Central Book Depot, Allahabad.
- f) Parihar, N.S (1996). The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
- g) Puri, P (1980). Bryophytes. Atma Ram & Sons, New Delhi.
- h) Sporne, K.R (1991). The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd.
- i) Sporne, K.R. The Morphology of Gymnosperme. B.I. Publications, New Delhi.
- j) Bhatnagar, S.P. and Moitra, A (1996). Gymnosperms, New Age Int. Pvt. Ltd., New Delhi.

BOT-PG-EP-310: SECONDARY METABOLITE ANALYSIS LAB

1. Determination of tannins.
2. Determination of flavonoids.
3. Pharmacological screening of Anti-diabetic Agents.
4. Pharmacological screening of Hepatoprotective Agents.
5. Determination of anti-oxidant activity from local plants.
6. Screening of Crude Drugs for Anti-microbial activity.
7. Phytochemical screening methods: Paper Chromatography, TLC, HPLC, Spectrometry.
8. Estimation of Alkaloids from local plants.
9. Identification of amino acids by Paper Chromatography.
10. Identification and Estimation of Lipids
11. Qualitative determination of Phenols from local plants.
12. Determination of adulteration in crude drugs.

References

- a) Horborne, J.B. 1983. Phyto chemical methods. Chapman and Hall. London.
- b) Trease, G.E. and Evans W.C. Pharmacognosy. 12 Edition. Bailliere, Tindall, East Bourne, U.K. 1983.

- c) Kokate, C.K., Purohit A.P. and S.B. Gokhale. Pharmacognosy. Nivali Prakashan
- d) Miller, L.P. Phyto chemistry. 1-3 volumes Van Nostrand, Reinhold Co. 1973.

BOT-PG-EP-311: INTRODUCTION TO PLANT DISEASES

1. Preparation of culture media.
2. Methods of sterilization.
3. Isolation of pathogen from diseased tissue.
4. Study of the Fungal diseases: Club root, Damping off, White rust, Early and late Blight, Downy mildew, Powdery mildew, Smut, Rust, leaf spot, Anthracnose, Rot, Wilt.
5. Bacterial Diseases: Citrus canker, Blight and Leaf Spot, Grassy shoot disease and Little leaf,
6. Viral disease: TMV, Yellow mosaic
7. Nematode disease: Root knot
8. Treatment methods for Seed/propagules disinfection for disease free planting
9. Treatment methods for soil disinfection
10. Diagnosis of plant diseases using molecular tools.

References:

- a) Agrios, G. N. 1978: Plant Pathology
- b) Aneja, K. R. 1993: Experiments in Microbiology, plant pathology and Tissue culture

BOT-PG-EP-312: PLANT PHYSIOLOGY LAB-1

1. To determine the chl-a/chl-b ratio in C₃ and C₄ plants
2. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids
3. Seed viability of different seeds using TTC and DCPIP test
4. Study of photolysis of water by Hill reaction with isolated chloroplast
5. Determination of free amino acids from plant sample with paper chromatography or TLC
6. Breakdown of seed dormancy by cold treatment or scarification
7. Determination of sugars in germinating seeds by TLC
8. Study of membrane permeability from leaves of different chronological ages by direct conductivity meter.
9. Analysis of proline in normal and water stressed or salt stressed plants
10. Estimation of vitamin-C from suitable plant material
11. Study of effect of plant hormones in seedling growth.
12. Study of seed germination, amylase activity and its induction by GA

References:

1. Bewly, JD and Black E. 1980. Seeds: physiology of development and germination. Plenum Publishing Corporation.
2. Darwin, Fand Hamilton Acton E. 2011. Practical Physiology of Plants (Reissue edition), Cambridge University Press, Cambridge, UK

3. Dennis, D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
4. MacDougal, DT. 2009. Practical Text-Book of Plant Physiology, University of Michigan Library, Michigan, USA
5. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA.
6. Moore, TC. Research experience in plant physiology-a laboratory manual. Springer-Verlag
7. Nobel, P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
8. Singhal, G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.

BOT-PG-EP-313: PLANT CELL & TISSUE CULTURE AND GEN. ENG. LAB

1. Requirement for Plant tissue culture works: Work station, equipments and culture conditions.
2. Preparation of MS media stock solution and hormones.
3. MS Media Preparation & Sterilization.
4. Preparation of explants & callus induction techniques.
5. Induction of Somatic embryogenesis.
6. Isolation of protoplasts.
7. Suspension culture.
8. Preparation of synthetic seeds.
9. Isolation of DNA from Plant tissues.
10. Restriction enzyme digestion of genomic DNA and gel electrophoresis.
11. *Agrobacterium*- mediated gene transfer in common plants, Arabidopsis.
12. Molecular and histochemical analysis of transgenic plants.

References:

- 1) Krishnamurthy, K.V, 1988. Methods in plant histochemistry. Viswanathan Printers and Publishers, Chennai.
- 2) Lindsley, K. 1992. Plant tissue culture manual. Kluwer Academic publishers.
- 3) McClung, C.L, 1961. Hand book of Microscopic technique. MacGraw Hill, New Delhi.
- 4) Purvis, C.J., Collen, D and Walls, D. 1966. Laboratory technique in Botany. Orient Longman, Singapore.
- 5) Reinert, J and Yeoman, M.M 1983 Plant cell and Tissue culture- Laboratory manual, Narosa publishing house, New Delhi
- 6) Patki, L.R, 1992. An introduction to Microtechnique. S. Chand & Co, New Delhi.
- 7) Prasad and Prasad, 2000. Outlines of Microtechnique. Emkay publ, New Delhi.
- 8) Thorpe, T.A. 1981. Plant tissue culture methods and application in agriculture, Elsevier, London

**SEMESTER-IV
OPTIONAL THEORY-II PAPERS**

**BOT-PG-ET-401
FUNDAMENTAL & ADVANCED PLANT SYSTEMATICS**

Unit I: CONCEPTS IN PLANT SYSTEMATICS

Taxonomic hierarchy, the species concept; Plant Speciation: Allopathic / Abrupt / Sympatric / Hybrid / Apomictic speciation, Isolating mechanisms; Biosystematics: Steps in biosystematics, Biosystematic categories, Importance of Biosystematic studies; Systems of Angiosperm Classification: Phenetic versus phylogenetic systems. Cladistics in taxonomy, Angiosperm phylogeny group (APG)

Unit II: INTERDISCIPLINARY PLANT TAXONOMY

Embryology in relation to taxonomy: Embryological characters of taxonomic importance, utilization of embryological data in solving taxonomic problems. Anatomy in relation to taxonomy: Vegetative, wood and floral anatomy, anatomical characters of taxonomic importance, use of anatomical data in understanding interrelationship and evolution of angiosperms and solving taxonomic problems. Palynotaxonomy: Pollen morphology-Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern, palynogram; pollen characters of taxonomic importance.

Unit III: CHEMO AND CYTOTAXONOMY

Cytotaxonomy: Chromosome number, Basic chromosome number, polyploidy, aneuploidy, chromosome morphology, karyotype, chromosome banding, meiotic analysis and plant systematics, scope and limitations; Chemotaxonomy: Origin of chemotaxonomy, classes of compounds and their biological significance, Stages in chemotaxonomic investigations, techniques, Use of chemical criteria in plant taxonomy.

Unit IV: NUMERICAL TAXONOMY & MOLECULAR SYSTEMATICS

Numerical Taxonomy: Principles, construction of taxonomic groups, OUTs, unit characters, character coding, measurement of resemblances, cluster analysis, phenons and ranks, discrimination, nomenclature and numerical taxonomy, merits and demerits. Cladistics and cladogram: Concepts, parsimony, cladograms and trees; characters: apomorphic and plesiomorphic characters, homologous vs analogous; character states, binary and multistate characters, characters transformations; morphometric vs molecular characters. Trees - monophly, polyphyly and paraphyly; rooted and unrooted. Tree construction – algorithmic (UPGMA and Neighbour Joining) and tree-searching (Parsimony, Maximum Likelihood and Bayesian).

Introduction to Molecular Systematics; Generating molecular data, Types of molecular data, conserved genes for taxonomic analyses – Nuclear, Plastid and mitochondrial genes; molecular characters; homoplasy, phylogeny reconstruction, methods of estimating genetic diversity using molecular data and its modifications. Applications of molecular systematics in Plant taxonomy.

References

1. Michael, G. Simpson. Plant Systematics. 2006. Elsevier Academic Press, Burlington, MA.
2. Gurcharan Singh, Plant Systematics, (2 ed.), 2004. Ox. & IBH Publ. Co, Pvt. Ltd., New Delhi.
3. Hillis, D.M., Mortiz, C. & Mable, B.K. (eds.) 1996, Mol. Systematics, Sinauer Associates, Sunderland, USA.
4. Harborne, J.B. & Turner, B.L. 1984, Plant Chemosystematics, Academic Press, London.
5. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York
6. Johri, B. M. 1984. Comparative embryology of Angiosperms. Ind. Nat. Sc. Acad. New Delhi
7. Principles and Techniques of Contemporary Taxonomy Blakie Academic & Professional, London.
8. Sharma Arunkumar and Archana Sharma. 1980. Chromosome Technique: Theory and Practices 3rd ed. Butterworths, London.
9. Judd Walter S., Campbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC Publishers. Sunderland, Massachusetts.

BOT-PG-ET-402

PLANT SECONDARY METABOLITE AND ANALYSIS

Unit I: DEFINITION, IMPORTANCE AND SYSTEMATICS OF SECONDARY METABOLITES

Phenolic acids, alkaloids, glycosides, terpenoids, flavonoids, steroids, tannins in plants kingdom. Function of secondary metabolite for plant defense and protection.

Unit II: HISTORY, CLASSIFICATION, PROPERTIES, DISTRIBUTION IN NATURE

Extraction, biosynthesis, biological role and applications of alkaloids, lignin, suberin, phenolic acids, flavonoids, steroids, terpenoids, tannins, pigments (Carotenoids, Anthocynins), and glycosides.

Unit III: THERAPEUTIC EFFECTS AND PHARMACEUTICAL APPLICATIONS OF ALKALOIDS, TERPENOID, GLYCOSIDES, VOLATILE OILS, TANNINS AND RESINS

Secondary metabolite: Their physiological role, ecological and phylogenetic importance.

Unit IV: SECONDARY METABOLITES IN THE MAIN FOODSTUFF

Toxicity of natural and artificial products. Production of secondary metabolites by plant cell cultures. Terpenoids, the synthesis of IPP (isopentenyl pyrophosphate) in the cytosol and plastid.

References:

1. Dey, P.M. and J.B. Harborne: Plant Bio Chemistry Academic Press, London.
2. Sadasivam. S. and A. Manickam: Bio Chemical methods 2nd edition. New Age International Pvt. Ltd. New delhi.
3. Dennis D.T., Turpin, D.H. Lefebvre, Layzell D.D and D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
4. Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S. Chand Publications

5. Leninger A.C 1987. Principles of Biochemistry, CBS Publishers and Distributers (Indian Reprint).

BOT-PG-ET-403: CROP PROTECTION AND MANAGEMENT

Unit I: PRINCIPLES OF DISEASE MANAGEMENT

Disease avoidance, Pathogen exclusion, Eradication of pathogen, Resistance to pathogen, Plant protectants (Fungicides, bactericides, pesticides and herbicides). Biological pest control and diseases, Storage pest and diseases.

Unit II: PLANT DISEASE CONTROL

Cultural, chemical, biological plant disease management, biopesticides, breeding for resistant varieties, Plant quarantine, integrated pest management.

Unit III: FUTURE PROSPECTS OF PLANT DISEASE MANAGEMENT

Exploitation of pre penetration and penetration events, enhancing plant tolerance, resistance mechanism, transformation of plants to enhance resistance. Fungicide resistance.

Unit IV: MODERN ASPECTS OF PLANT DISEASE MANAGEMENT

Uses of modern biotechnological tools in crop management. Testing for host resistance to diseases.

References

1. R.P. Singh, (2005) Plant Pathology. Kalyani Publishers Ludhiana.
2. Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi Biotechnology. Oxford & IBH, New Delhi.
3. Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving
4. Fry W.E. 1982. Principles of Plant Disease Management. Academic Press, New York
5. Hewitt HG. 1998. Fungicides in Crop Protection. CABI, Wallington.
6. Marsh RW. 1972. Systemic Fungicides. Longman, New York.
7. Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control. Oxford & IBH, New Delhi.
8. Palti J. 1981. Cultural Practices and Infectious Crop Diseases. Springer-Verlag, New York.
9. Vyas SC. 1993 Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

BOT-PG-ET-404: PLANT METABOLISM

Unit I: CARBOHYDRATE METABOLISM

Gluconeogenesis; Stoichiometry and energy balance of gluconeogenesis; Regulation of gluconeogenesis; Glycogen biosynthesis; Catabolism of polysaccharides; Pentose phosphate pathway

Unit II: LIPID METABOLISM

Biosynthesis of fatty acids; Oxidation of lipids: β , α and ω oxidation of fatty acids; Stoichiometry of β -oxidation; Triacylglycerol synthesis; Metabolism of cholesterol and its regulation

Unit III: AMINO ACID METABOLISM

Classification of amino acids; General reactions of amino acid metabolism; Biosynthesis of aromatic amino acids; Amino acid proline and stress response; Glutathione: metabolism and function; Amino acid degradation; Urea cycle and its regulation

Unit IV: SECONDARY METABOLITES

Secondary metabolites: introduction and functions; Biosynthesis of secondary metabolites with special reference to phenolics; Plant defenses against pathogens; Metabolic engineering in the production of pharmaceuticals; Alkaloids: Nomenclature, classification and uses; Biosynthesis of alkaloids

References

1. Voet and Voet, 1992. Biochemistry, John Wiley & Sons, Inc., New York.
2. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H.
3. Freeman and Company, New York
4. Bowsher et al., 2008. Plant Biochemistry, Garland Science, New York
5. Mathews, Van Holde and Ahern. 2007, Biochemistry (3rd Ed), Pearson Education, Delhi
6. Dey PM and Harborne JR. 2000, Plant Biochemistry, Harcourt Asia Pvt. Ltd., Singapore
7. Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.

BOT-PG-ET-405: MOLECULAR GENETICS, GENOMICS & PROTEOMICS

Unit I: NUCLEAR STRUCTURE & ORGANIZATION

Nucleic acids: Molecular structure of DNA & RNA, bonds & thermodynamics of nucleic acid organization; Chromosome Structure, packaging of DNA in chromosomes; Genome architecture: Overview, general structure, difference between prokaryotic & eukaryotic genomes; Cytoplasmic genomes: mitochondrial and chloroplast genomes, C-Values of plant genomes & C-value paradox.

Unit II: TOOLS IN MOLECULAR GENETICS

Nucleic acids: Isolation, purification & quantification; Hybridization Techniques: Northern & Southern hybridization & applications; DNA libraries: Construction and screening of genomic & cDNA libraries; PCR: Principle, methods & variants, RT PCR & applications; Microarray, ELISA. Transposons and applications.

Unit III: GENOMICS

Plant Genome Analysis: Classes of molecular markers & applications, genetic and physical mapping. DNA sequencing methods, Maxam and Gilbert method, Ladder, Fluorescent, Shot Gun, Mass Spectrometry, Next Generation Sequencing methods, data analysis, bioinformatics tools in NGS data analysis. Applications of DNA sequencing to crop improvement.

Unit IV: PROTEOMICS

Introduction and scope of proteomics; Protein separation techniques: Ion-exchange, Size exclusion

and Affinity chromatography techniques; Polyacrylamide gel electrophoresis; Isoelectric focusing (IEF); Two dimensional PAGE for proteome analysis; Western blotting, Image analysis of 2D gels; Introduction to mass spectrometry: Strategies for protein identification; Protein sequencing; Protein modifications and proteomics; Applications of proteome analysis to drug; Protein-protein interaction (Two hybrid interaction screening); Protein engineering; Protein chips and functional proteomics; application of proteomics to plant sciences; Proteome database; Proteomics industry.

References

1. R.M. Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.
2. P. Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersey, 2003.
3. De Robertis and De Robertis, 1990, Cell and Molecular Biol., Saunders College, Philadelphia
4. Weaver, R.F. and Hedrick, P.W., 1989, Genetics. Wm, C. Brown Pub, Dubuque.
5. Freifelder D. 1987, Molecular Biology. Jones and Bartlett, Boston.
6. Watson J.D. *et. al.*, 2004, Molecular biology of the gene, Pearson education, Singapore.

ELECTIVE THEORY-III PAPERS

BOT-PG-ET-406

BIODIVERSITY CONSERVATION: LEGAL & ETHICAL FRAMEWORK

Unit I: BIODIVERSITY

Definition, concepts and types of biodiversity. Biodiversity scenario at global, national and regional level, Value of biodiversity. Biodiversity losses: past and present (vulnerability of species in relation to extinction, ecological parameter). Causes of biodiversity loss: forest fragmentation, Impact of fire wood extraction; Forest fire, landslides, floods, GLOF, climate change. Threats to biodiversity: Invasive species, empty forest.

Unit II: CONSERVATION OF BIODIVERSITY

Conservation of biological species, priority of conservation, current trends in conservation. Role of institutes for the conservation (*in situ* & *ex situ* conservation), Role of Zoological parks, wild life sanctuary, national parks, botanical garden, conservatorium etc. Sacred groove, community forest, Joint Forest Management (JFM), biogeography (flora & fauna). Biodiversity hot spot, Eastern Himalayan elements, trans Himalayan elements, Western Ghat elements, endemism, keystone species, indicator species.

Unit III: ECONOMICS OF BIODIVERSITY

Economic value of biodiversity, conservation & livelihood, Nagoya protocol. Basic tenets of working with indigenous & rural people, Traditional knowledge and biodiversity conservation. Participatory approach in natural resource management, enterprise based conservation initiatives-eco-tourism, eco- feminism, eco-capitalism, village tourism, trekking, nature walk, bird watching etc, access to genetic resources & benefit sharing.

Unit IV: LEGAL & ETHICAL FRAMEWORK

Laws, policies and institutions for conservation, NBSAP, NGO, Government agencies (Ministry of Environment & Forest), Forest Conservation Act 1927, Ramsar site (Convention), Biodiversity Act. People Biodiversity Register Book, Environment Protection Act 1986, Environment Law, Kyoto protocol, Convention on Biological Diversity (Rio Earth Summit 1992, 2012), Durban agreement, IUCN categorization. Red data books, green book, blue book

References:

1. Cobley, L.S. and Steele, W.M. (1976). An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
2. Hill, A.F. (1952). Economic Botany. (2nd Ed.) McGraw Hill, New York.
3. Kochar, S.L. (1981). Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
4. Krishan Arora (2005). Forest Laws. Professional Book Publishers, New Delhi.
5. Simmonds, N.W. (1976). Evolution of Crop Plants. Longman, London, New York.
6. SambaMurthy, AVS and Subrahmanyam, N.S. (1989). A Text Book of Economic Botany. Wiley Eastern Ltd., Delhi
7. Trotter, H. (1982). The Common Commercial Timbers of India and their uses. Controller of Publications, Delhi.

BOT-PG-ET-407

QUALITY CONTROL, QUALITY REGULATION AND CLINICAL RESEARCH OF HERBAL DRUGS

Unit I: INTRODUCTION TO QUALITY CONTROL

Introduction to quality control, techniques for quality control, monitoring and regulation. Quality control with reference to WHO guideline. Common problems encountered, maintenance of quality of crude drugs. Adulteration and deterioration of herbal produce. Factors affecting herb quality.

Unit II: QUALITY CONSIDERATION IN HERBAL DRUGS

Determination of Foreign Matter, Ash, Radioactive Contamination, Pesticide Residues, Microbial Contaminants and Aflatoxins, Heavy Metals. Sampling procedure, standard techniques for collection and processing, packaging and maintenance of herbs and herbal produces. Morphological examinations and microscopical evaluation of herbal produce.

Unit III: SAFETY & EFFICACY OF HERBAL DRUGS

Safety and efficacy of herbal drugs. WHO guidelines for the assessment of herbal drugs. An overview of : The D & C Act 1940 and rules there under, The Patents and Designs Act 1970, Trademarks. Safety and efficacy regulations for licensing new patent and proprietary botanical medicines. Preparation of documents for New Drug Application (NDA) as per requirements of FDA and EUDRA guidelines. FDA and EUDRA guidelines. Indian Systems of Medicine and Homeopathy (ISM&H). Indian regulation of Manufacture of Ayurvedic, Siddha and Unani.

Unit IV: CLINICAL RESEARCH

Definition, scope and importance of clinical research of herbal drugs. Classification of Clinical Research. Issues of clinical research of herbal drugs -Effectiveness of a Traditional Herbal drugs, the Chemical Constituents of Herbal drugs, Safety and efficacy of herbal medicines.

References

1. Mukherjee P.K. (2002). Quality control of Herbal Drugs – An approach to Evaluation of Botanicals, Business Horizons, New Delhi, 1st Edition.
2. Forensic Pharmacy by B.S. Kuchekar, A. M. Khadatare and S. C. Jitkar, 6th Ed., Nirali Prakashan
3. Drugs and Cosmetics Laws by Krishnan Arora, Professional Book Publishers, New Delhi
4. Mittal B.M., A Textbook of Forensic Pharmacy, 9th Ed., Vallabh Prakashan
5. James Swarbrick, James C Boylon, Encyclopedia of Pharmaceutical Technology, 2nd Ed. Marcel Dekker Inc.
6. Deshpande S.W., Drugs and Cosmetic Act.1940
7. Bubuarman N.R, Whatever one should know about patent, 2nd Ed., Pharma Book Syndicate
8. Gnarino Richard A, New Drug Approval Process, 3rd Edition, Marcel Dekker In Deshpande S.W, Drug and Magic Remedies Act 1954.
9. P. Warayan, Intellectual Property Laws, Eastern Law House.
10. Drug and Cosmetic Act 1940, Eastern Book company by Vijay Malic, 11th Ed. Patents for Medicine, by N. B. Zareri, Indian Drug Manufacturers ssociation (IDMA)
11. Pharmacy Law and Ethics by Dale and Appelbes, The Pharmaceutical Press, Joy Winfield.

BOT-PG-ET-408 SEED TESTING & PLANT QUARANTINE

Unit I: SEED HEALTH

History and economic importance of seed pathology in seed industry. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens. Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds.

Unit II: SEED TECHNOLOGY

Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection. Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Unit III: INTRODUCTION TO PLANT QUARANTINE

Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material. Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine, domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

Unit IV: QUARANTINE REGULATION IN INDIA

Plant protection organization in India. Acts related to registration of pesticides and transgenics. PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents. WTO regulations; non-tariff barriers; Pest risk analysis. Sanitary and Phytosanitary measures.

References

1. R Agarwal VK & JB Sinclair. 1993. Principles of Seed Pathology. Vols. I & II, CBS Publ., New Delhi.
2. Hutchins JD & Reeves JE. (Eds.). 1997. Seed Health Testing: Progress Towards the 21st Century. CABI, Wallington.
3. Paul Neergaard. 1988. Seed Pathology. MacMillan, London.
4. Suryanarayana D. 1978. Seed Pathology. Vikash Publ., New Delhi. Rajeev K & Mukherjee RC. 1996. Role of Plant Quarantine in IPM. Aditya Books.
5. Rhower GG. 1991. Regulatory Plant Pest Management. In: Handbook of Pest Management in
6. Agriculture. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

BOT-PG-ET-409: BIOCHEMISTRY

Unit I: PROTEIN BIOCHEMISTRY

Protein sorting and vesicle traffic; Machinery for protein sorting; Protein targeting to different organelles; Protein-DNA interactions; Protein degradation; Enzyme technology, Enzyme immobilization; Significance of ribozymes, abzymes and artificial enzymes Proteins in diseases: Alzheimer, Parkinson, BSE

Unit II: SIGNAL TRANSDUCTION

Overview, second messengers and G-proteins; Phospholipid signaling; Role of cyclic nucleotides Calcium-Calmodulin cascade; Protein kinases and phosphatases; Two component sensor-regulator system in bacteria and plants

Unit III: BIOCHEMISTRY OF IMMUNO MOLECULES

Introduction: immune system, organs, immune cells; Types of immunity: innate and adaptive; Antigens: types, properties, antigen-antibody interaction; Major histocompatibility complex: Class I and II MHC molecules
Cytokines: types, mechanism of action and therapeutic uses

Unit IV: NUCLEOTIDES

Biosynthesis of purine ribonucleotides; Purine degradation and disorders of purine metabolism
Biosynthesis of pyrimidine ribonucleotides; Salvage synthesis of pyrimidine nucleotide; Conversion of ribonucleotides to deoxyribonucleotides

References:

1. Alberts, B., Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1989. Molecular Biology of the cell, Garland Publishing Inc., New York.
2. Brown TA. (2002) Genomes, BIOS Scientific Publishers Ltd, Oxford.

3. Brown TA. (2008) Gene cloning and DNA analysis (5th Edition), Blackwell Publishing, Oxford, UK.
4. Lodish H, Berk A, Kaiser CA and Krieger M. (2008) Molecular Cell Biology, 6th Edition, W.H. Freeman and Company, New York, USA.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. 2004. Molecular Biology of the
6. Gene, Pearson Education, Singapore.
7. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H., Freeman and Company, New York, USA.
8. Kubly, J. 2000. Immunology, 4th edition, W.H. Freeman and Company, New York, USA.
9. Roitt *et al.*, 1998, Immunology 5th edition, Mosby International Ltd. London. UK.

BOT-PG-ET-410: BIOSAFETY, BIOETHICS AND IPR

Unit I: INTRODUCTION TO BIOSAFETY & BIOETHICS

Social and ethical issues in Biotechnology. Biosafety: Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products. public acceptance issues in biotechnology & biodiversity.

Unit II: REGULATORY AFFAIRS

Biosafety assessment procedures in India. International dimensions in biosafety: Cartagena protocol, bioterrorism and convention on biological weapons. Biosafety regulations and National and international guidelines with regard to rDNA technology, transgenic science, GM crops, etc. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP).

Unit III: INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS

Intellectual property rights, and Intellectual Property protection, patents and methods of application of patents, Trade Secrets copyrights, Trade Marks, legal implications; PPVFR: farmers rights, plant breeder's rights. Acquisition and management of IPRs.

Unit IV: TRADITIONAL KNOWLEDGE, BIOPIRACY, COMMUNITY RIGHTS

Traditional knowledge, issues of access, ownership, monopoly, benefit sharing, environmental sustainability. Biopiracy and traditional knowledge: Case studies of biopiracy: RiceTec Patent No. 5663484 in the USPTO, Monsanto's biopiracy of Indian wheat, Neem, Curcuma & Basmati Rice.

References

1. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.
2. Sasson A. Biotechnologies in developing countries present and future, UNESCO publishers, 1993.
3. Singh K. Intellectual Property Rights on Biotechnology, BCI, New Delhi.

BOT-PG-ET-411
ADVANCED TAXONOMY & ANGIOSP. SYSTEMATICS LAB

1. Tools of taxonomy – Types of tools, Field Tools, Laboratory Tools and Library Tools
2. Taxonomic literatures – Check lists, Floras, Keys, Monographs and Laboratory identification manuals.
3. Methods of field work, Non-destructive plant collection and documentation of the data; Maintaining field diary, Post-collection laboratory study of the plants, Herbarium preparation, Report writing, at least 3 local field visits.
4. Comparative studies of families from at least three major groups (series of orders) of dicotyledons and two major groups of monocotyledons (diagnostic characters of the families as per Bentham and Hooker's system of classification)
5. Identification of plants up to species level giving reasons
6. Preparation of artificial keys
7. Chemotaxonomy – Flower pigment analysis of plants from Caryophyllales and Curvembryae.
8. Palynotaxonomy – Study of pollen characters of taxonomic significance
9. Cytotaxonomy – Study of intergeneric / interspecific karyotypic differences.
10. Molecular Taxonomy: Specimen collection, Isolation of DNA, purification, quantification.
11. Amplification of ITS regions using standard primers, sequencing and construction of dendrograms.
12. Data analysis and interpretation of molecular taxonomy results.

BOT-PG-ET-412
UPSTREAM & DOWSTREAM PROCESSING LAB

1. Callus Induction Techniques – Carrot/Beet root/ or any other material
2. Development of suspension culture from callus for secondary metabolites
3. Cell disruption techniques
4. Solid-liquid separation methods – Filtration, Centrifugation, Sedimentation
5. Induction of Secondary metabolite – Anthocyanin
6. Estimation of Lycopene from tomato fruits
7. Estimation of Anthocyanin from leaf /callus tissue
8. Cell disruption techniques
9. Solid-liquid separation methods – Filtration, Centrifugation, Sedimentation
10. Biotransformation
11. Separation of Secondary metabolite using HPLC, HPTLC (Any example)
12. Purification and Characterization of High value metabolite (Any example)

References:

- a) Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.
- b) Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.
- c) Plant tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996) Elsevier, Amsterdam
- d) Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.

- e) Microbial Biotechnology by Alexander N Glazer, Hiroshi Nikaido, W H Freeman & Company New York.
- f) Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop (1990), Cambridge University Press, Cambridge.

BOT-PG-ET-413: SEED TECHNOLOGY LAB

- 1) Plant protection equipments, their safe handling & use.
- 2) Testing seed germination: Substrate and moisture holding capacity of seed.
- 3) Pre treatments – Pre-drying, Pre-chilling, Scarification, Stratification, Chemical treatments, hot water treatments.
- 4) Visual examination of dry seeds for disease symptoms. (Any five)
- 5) Examination of suspensions obtained from washings of seed.
- 6) Viability test- space germination test and tetrazolium test.
- 7) Detection of important seed borne fungi (Any two).
- 8) Detection of important seed bore bacteria (Any two).
- 9) Fumigation-principle and practical application.
- 10) Types of insecticide formulations, their preparation & safe use.
- 11) Use of SDS PAGE in seed testing
- 12) Use of PCR in seed testing

References:

- a) Neergaard – Seed Pathology Vol.I & II.
- b) Agarwal.V.E. & Sincelair, J.B. Principles of seed pathology Vol.I & II.
- c) K.A. Jeffs-Seed treatment.
- d) C.J. Alexopoulos – Introductory mycology.
- e) J.P. Shrivastava – An Introduction to fungi.
- f) R.W. Marsh – Systemic Fungicides.
- g) Mary Noble & M.J. Richardson – An annotated list of sea-borne diseases.
- h) Metcalf & Flint –Destructive & useful Insects.
- i) J.B. Free – Insect pollination of field crops.
- j) D.S. Bindra- Plant Protection and equipments.

BOT-PG-ET-414: BIOCHEMISTRY LAB

- 1. Estimation of DNA (DPA Method)
- 2. Estimation of total proteins [Bradford's / Lowry's]
- 3. Study of Enzyme Kinetics (experiments with acid phosphatase)
- 4. Effect of temperature on enzyme activity.
- 5. Effect of pH on enzyme activity.
- 6. Effect of [E] on enzyme activity.
- 7. Effect of [S] on enzyme activity; measurement of Vmax and Km.
- 8. Estimation of Ascorbic acid [Calorimetric / volumetric]
- 9. Estimation of Riboflavin
- 10. Estimation of Phenolics [Folin – Ciocalteau]

11. Estimation of Tannins [Folin – Denis / Vanillin hydrochloride]
12. Estimation of total lipids and cholesterol.

References:

- a) Wilson, E. & Goulding, K.H. 2000 A Biologists' Guide to Principles and Techniques of Practical Biochemistry ELBS.
- b) Jayaraman, J. 1985. Laboratory Manual of Biochemistry, Wiley Eastern Limited. New Delhi.
- c) Modern Experimental Biochemistry, (3rd Edn.) R. Boyer, Benjamin Cumming, 2000.
- d) Practical Biochemistry, Principle and Technique (5th Edn.) K. Wilsen and J. Walker, Cambridge University Press. 2000.
- e) Plant Biochemistry, P.M. Dey and J.B. Harborne, Harcourt Asia Ltd. Academic Press, 1997.

BOT-PG-ET-415
MOLECULAR BIOLOGY & GENETIC ENGINEERING LAB

1. Isolation of Plasmid DNA (Ti Plasmid) from *E.coli* cells.
2. Transformation of *E.coli* with plasmid, selection of transformants by blue-white screening.
3. Transformation of *A. tumefaciens* with binary vector and selection for transformants.
4. Transformation of plant tissues using *A. tumefaciens* based vectors. Detection of transformants using GUS assay.
5. Southern blotting and detection of specific DNA fragments.
6. Primer design using online softwares.
7. Polymerase Chain Reaction for screening of transformants.
8. Genotyping using molecular markers.
9. Linkage map construction using molecular marker data.
10. Real time PCR and differential display.

References:

1. Mitra Sandhya 1996, Genetic Engineering Macmillan India Ltd.
2. Lal R. and Lal S. 1993, Genetic engineering of plants for crop improvement. CRC Press.
3. Winkler, U. Ruger W. and Wackernagel W. 1979. Bacterial phage and molecular genetics. Narosa Publication New Delhi.
4. Gustafson J. P. 1990 Gene manipulation in plant improvement I and II. Plenum Press London.
5. Old R. W. and Primrose S. B. 1989 Principles of Gene Manipulation. Blackwell Scientific Publ Oxford.
6. Razdan M. K. and Cocking E. C. 2000 Conservation of plant genetic resources in vitro. Oxford and IBH publishing Co. Pvt. Ltd.
7. Razdan M. K. and Bhojwani S. S. 1996, Plant tissue culture: Theory and practice a revised edition. Elsevier Science.
8. Trigiano R. N. and Gray D. J. 2000 Plant tissue culture concepts and laboratory exercises. CRS press LLC.
9. Gustafson J. P. 2000 Genomes. Kluwer Academic Plenum Publishers New York USA.