

**BOT 503**

**BIOPROSPECTING AND PLANT RESOURCE UTILIZATION**

- Unit I: Bioprospecting: Definition, Introduction, Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources.  
Bioprospecting Act: Introduction, Phases of Bioprospecting, Exemption to Act. Fields of Bioprospecting.
- Unit II: Medicinal Plants Bioprospecting/ Pharmaceutical Bioprospecting: for new drugs, assays in Bioprospecting. Antioxidant assay – NO free radical scavenging assay, Antigenotoxicity assay – MTT assay, Antiviral activities of plants – SRB assay.
- Unit III: Marine Bioprospecting: Sources of marine planktons and their Bioprospecting, Isolation and cultivation of Marine bioresources, Isolation of Marine Yeast and its industrial applications, Bioactive chemicals from Seaweeds and their applications.
- Unit IV: Microbial Bioprospecting: Isolation of Microbial metabolites and their bio-activity. Endophytic microbial products as Antibiotics.
- Unit V: Origin, evolution, botany, cultivation and uses of Food, Fodder, Fibers, Oil yielding crops, wood and timber, Non-wood forest products(NWFPS): Bamboos, Gums, Dyes, Resins, Fruits etc.
- Unit VI: Botany, Chemistry, Properties and uses of Medicinal and Aromatic plants.
- Unit VII: Research Methodology: Separation of secondary metabolites, Pharmacognostic procedures, Authentication of specimens, Preservation of plants and plants products.

**Laboratory exercise:**

- 1. Food Crops:** Morphology, anatomy, micro-chemical test for stored material: Wheat, rice, maize, chickpea, potato, sweet potato, sugarcane,
- 2. Study of fodder / forage Crops:** Jowar, Bajra, lucerne, Maize etc.
- 3. Plant fibers:** Cotton, jute, sun hemp, coir, silk cotton: Morphology microscopic study anatomy of whole fibers, using appropriate staining methods.
- 4. Medicinal and aromatic plants:** At least 5 medicinal and 5 aromatic plants and their morphology, anatomy, phyto-chemistry.
- 5. Oil yielding crops:** Mustard, groundnut, soybean, coconut, sunflower, castor: Morphology, microscopy of oil yielding tissue, test for oil, acid, Iodine numbers.
6. Gum, resin, tannin, dye yielding plants.
7. Fire wood and timber yielding plants.

8. **Antioxidant assay** – NO free radical scavenging assay.
9. **Antigenotoxicity assay** – MTT assay.
10. **Antiviral activities of plants** – SRB assay.
11. Scientific visits to laboratories / Industries / Research Institutes and field and submission of report.

#### **References**

1. Arora, R.K. and Nayar, E.R. (1984), Wild relatives of crop plants in India, NBPGR Science Monograph No.7.
2. Baker, H.G. (1978), Plants and civilization. III Ed. (A. Wadsworth, Belmont).
3. Bole, P.V. and Vaghani, Y. (1986). Field guide to common Indian trees, Oxford University Press, Mumbai.
4. Thakur, R.S., Puri, H.S. and Husain, A. (1969). Major medicinal plants of India, Central Institute of medicinal and aromatic plants, Lucknow.
5. Swaminathan, M.S. and Kocchar, S.L. (Es.) (1989). Plants and Society, MacMillan Publication Ltd.,
6. Sharma, O.P. (1996). Hills Economic Botany, Tata McGraw Hill co., Ltd., New Delhi,
7. Kocchar, S.L. (1998). Economic Botany of the tropics, II Edn. MacMillan India Ltd.,
8. CSIR (1986), The useful plants of India Publication and Information directorate, CSIR^ New Delhi.
9. CSIR (1948 - 1976) The wealth of India, 53

**BOT 504**

**Genetic Engineering and Bioinformatics**

**Unit I Genetic Engineering of Plants:** Aims, strategies for development of transgenic.

Transformation and regeneration of plants, DNA delivery systems- *Agrobacterium tumefaciens*, Direct gene transfer. The selection and analysis of transformants. Plant regeneration systems, Stability of the transgenes and Environmental risk assessment. Gene targeting - Transformation of recalcitrant species.

**Unit II Microbial genetic Manipulations:** Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology.

**Unit III Introduction to Bioinformatics-** Definition of Bioinformatics- History of Bioinformatics, scope and application of Bioinformatics. Fundamentals of Internet, www, HTML, URLs, Role of internet and www in bioinformatics.

**Biological Data Acquisition-** The form of biological information; DNA sequencing methods – basic DNA sequencing, Types of DNA sequences – genomic DNA, cDNA, Expressed sequence tags (ESTs), Genomic survey sequences (GSSs);

**Databases: Format and Annotation:** Common sequencing file formats – NBRF/PIR, FASTA, Files for multiple sequence alignment – multiple sequence format (MSF), ALN format; Files for structural data – PDB format.

**Unit VI Bioinformatics Databases:** Primary sequence databases (GenBank-NCBI, the nucleotide sequence database-EMBL, DNA sequence databank of Japan-DDBJ; Protein sequence and structure databases (PDB, SWISS-PROT and TrEMBL); Derived (Secondary) Databases of Sequences and Structure: Prosite, PRODOM, PRINTS, Pfam, BLOCK, SSOP, and CATH. Enzyme Database, Biodiversity Database.

**Unit V Technique's in Bioinformatics- Sequence alignment, database searching and structure prediction:** Pairwise sequence alignment, Database similarity searching, FASTA, and BLAST. Multiple sequence alignment and analysis with CLUSTAL X and CLUSTAL W. Measurement of sequence similarity; Similarity and homology. Phylogenetic tree. Phylogenetic data analysis, tree building methods, tree evaluation & interpretation methods. Phylogenetic analysis with PHYLIP software. Prediction of secondary and tertiary structures with different software's and tools. Structure visualization software's RasMol, SpdbViewer etc.

**Unit VI. Introduction to Genomics and Proteomics:** Introduction to genomics- scope and application, Computational genomics, Organization of the prokaryotic and eukaryotic

genomes, Human Genome Project. Genome maps and types, current sequencing technologies, partial sequencing, gene identification, gene prediction rules and software, Genome databases; Annotation of genome, Genome diversity: taxonomy and significance of genomes – bacteria, yeast, Homo sapiens, Arabidopsis, etc.

Functional Genomics - Microarray - Gene Expression, methods for gene expression analysis; Applications of DNA microarray.

**Unit VII. Research Methodology:** Computer applications- Data Processing with MS word, MS Office, Power point Presentation, MS Excel, Searching references with the help of Internet.

### **Laboratory Exercise**

- 1) Different file formats –Genbank, Genpept, FASTA, EMBL, NBRF/PIR, , PDB file format.
- 2) Entrez and Literature Searches. PubMed, PubMed central, OMIM / OMIA.
- 3) Primary sequence Databases- NCBI, EMBL, DDBJ.
- 4) Protein Structure Database– PDB.
- 5) Prediction of secondary structure of proteins.
- 6) Visualization of tertiary structure of proteins in Rasmol.
- 7) Accessing existing databases on www.
- 8) Sequence alignment – BLAST.
- 9) Homology search tools like BLAST and modeller.
- 10) Genomics- Genome databases, Annotation of genome, Prediction of ORFs dbSNP and other SNP related database .
- 11) GENSCAN and GeneMark.

### **Suggested Reading:**

- 1) Baxevanis, A.D. and Francis Ouellette, B.F. (1998) “Bioinformatics– a practical guide to the analysis of genes and proteins” John Wiley and Sons
- 2) Mount, D. (2004) “Bioinformatics: Sequence and Genome Analysis”; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1)
- 3) Sharma, V. Munjal, A. and Shankar, A. (2008) “A text book of Bioinformatics” first edition, Rastogi Publication, Meerut – India.
- 4) Bergman N. H. (2007), “Comparative genomics” Volume 2, Humana Press
- 5) Cantor C.R., Smith C.L., (1993) “Genomics: the science and technology behind the Human Genome Project” John Wiley and Sons

- 6) Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" Informa Healthcare
- 7) Clark M (2000), "Comparative genomics" Springer
- 8) Griffiths A. J. F., Miller J.H., Suzuki D.T., (2000) "An Introduction to Genetic Analysis" W.H. Freeman and Co., Publishers.
- 9) Pevsner J (2009), "Bioinformatics and functional genomics", Edition 2, John Wiley and Sons
- 10) Primrose S. B., Twyman R. M. (2004), "Genomics: applications in human biology" Wiley-Blackwell
- 11) Primrose S. B., Twyman R. M. (2006), "Principles of gene manipulation and genomics" Wiley-Blackwell
- 12) Saccone C., Pesole G., (2003), "Handbook of comparative genomics: principle and methodology" John Wiley and Sons
- 13) Suhai S (2000), "Genomics and proteomics: functional and computational aspects" Springer

**BOT 505**

**Research Methodology - II**

- Unit I: **Introduction of Research:** Meaning of Research, Objectives and types, Research Process, Criteria of good research, defining the research problem.
- Unit II: **Research Methodology:** Designing, features and concepts of good design, basic principles of experimental design, sampling design- its steps and types, random sampling, measurement and scaling techniques in research.
- Unit III: **Method of data collection:** primary and secondary data, observation method, interview method, questionnaires, schedules, characteristics of data.
- Unit IV: **Interpretation and report writing:** meaning, techniques of interpretations, precautions in interpretation, significance of report writing, different steps in report writing, types of report, review writing- review of literature, scientific books and scientific papers.
- Unit V: Preparing project proposals for financial assistance to various funding agencies.

**Suggested Reading:**

1. Kothari, C. R. 2009. Research Methodology-Methods and Techniques, 2<sup>nd</sup> Rev. Ed. New Age International Publishers, Delhi.

**OT 523 (Elective A)**  
**Advanced Genetics and Molecular Biology**

**UNIT I. MICROBIAL GENETICS:**

- A. Microorganisms as model systems for genetic studies:** Virus and phage organization, Lytic and temperate phages, recombination in phages and gene mapping.
- B. Recombination in bacteria:** transformation, transduction, conjugation and gene mapping, Tetrad analysis in fungi.

**UNIT II. HUMAN GENETICS AND CANCER:**

- A. In born errors of metabolism:** Human karyotype, the chromosomal basis of genetic disorders and syndromes, amniocentesis, genetic counseling.
- B. Genetic basis of cancer:** Forms of cancer, genetic basis, cancer and cell cycle, oncogenes, genetic pathway to cancer, genetic counseling.

**UNIT III. GENOME ORGANIZATION:**

- A.** Genome size variation, cot curve analysis, DNA complexity, LINES and SINES, gene amplification and gene families.
- B.** Mitochondria and chloroplast genome.

**UNIT IV. FUNDAMENTAL PROCESSES:**

- A. DNA replication, repair and recombination:** Overview, enzymes of replication, Replication apparatus, primosome and replisome, Replication mechanism, continuous and discontinuous DNA synthesis, supercoiling and termination of replication, Eukaryotic DNA replication, DNA repair mechanism and homologous and site-specific recombination.
- B. RNA synthesis:** Central dogma, role of DNA in protein synthesis, RNA polymerase, mechanism of transcription, eukaryotic transcription, Post transcriptional modification of in RNA, mapping and poly acetylation, split gene, introns, exons and gene splicing, reverse transcription.
- C. Protein synthesis:** Triplet code, deciphering the code, degeneracy, Translation: ribosomes, chain initiation, elongation and termination. Inhibitors of protein synthesis.
- D. Regulation of gene expression:** Prokaryotic: lac operon inducible system, CAP proteins and catabolic repression, his operon repressible system, Lac-operon attenuation control. Post transcriptional control, feedback inhibition and protein degradation, Eukaryotes : short term regulation, heat shock proteins, hormonal regulation, DNA methylation, Heterochromatin and gene inactivation.

**UNIT V: APPLIED BIOLOGY:**

- A. Genomics:** Structural genomics, cytogenetic maps, RFLP, RAPD, QT maps, FISH and chromosome specific library. Genome sequencing, human, yeast, *Arabidopsis*, genome projects, functional genomics expressed sequences, DNA chips and genome evolution.
- B. Genetic engineering:** Isolation of DNA, restriction endonucleases, construction of genomic library, screening of DNA library for desired gene, Southern, Northern and Western blotting, prokaryotic and eukaryotic vectors, DNA sequencing, Maxam and Gilbert's procedure, Sanger Coulson method, automated DNA sequencing machine, PCR and DNA amplification, Marker gene, reporter and selection marker gene, Ti plasmids and viral vectors, Direct gene transfer through electroporation, ballistic gun, micro injection, liposome and PEG mediated gene transfers. Application of recombinant DNA technology in medicine, industry and agriculture.

**Laboratory Exercise based on 523**

**Advanced genetics and molecular biology I & II**

1. Comparative radio-sensitivity in two crop species.
2. Isolation of genomic DNA using C-TAB method and quantification.
3. Evaluation of quality of isolated DNA.
4. Restriction and ligation reactions.
5. Agarose gel electrophoresis of DNA.
6. PCR amplification and RAPD marker.
7. Isolation of plasmid DNA
8. Conjugation in *E. coli*.
9. Study of growth curve in *E. coli*.
10. Substrate induced enzyme induction in plants.
11. Transformation in bacteria.
12. Isolation and quantification of total RNA and agarose gel electrophoresis.
13. Cytological effects of radiations and chemical mutagens in higher plants.

**Suggested Readings:**

1. Snustad, P.D. and Simmons, M.J. 2000, Principles of Genetics, 2<sup>nd</sup> Ed, John, Wiley and Sons, Inc., London.
2. Lewin, R. 1999, Human genetics, Concepts and applications. 3<sup>rd</sup> Ed, McGraw Hill, Dubuque, IA.
3. Lewin, B. 2000, Genes VII, Oxford University, New York.
4. Griffith, A.J.F., Miller, J.H. Suzuki, D.T. Lewontin, R.C. and Gilbert, W., 2000. Introduction to genetic analysis, 5<sup>th</sup> Ed. W.H. Freeman, N. Y.
5. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular cell Biology, Freeman, W.H. and Co., N. Y.
6. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. 1992, Recombinant DNA W.H. Freeman and Co., N.Y. A..c( Hi. (1994). Molecular Biology of cell, 3<sup>rd</sup> Ed. Garland
7. Albert A.et.al 1914 J.M.andGingold, E.B. 1993, Molecular biology and Biotechnology, Royal Soc., Publications,
8. U.K. If ftinaiin, R. 1991, Principles of Genetics, 3<sup>rd</sup> Ed. Win Brown, Dubuque, USA.
9. Brown J.A. 1992. Genetics, a molecular approach II Ed.
10. Tamarin, R. 1991 principals of Genetics III edition, Win brown , Duabuque, USA



**BOT 523 (Elective B)**

**Plant Pathology – IV**

**Unit I. Pathogenesis: Penetration and entry by plant pathogen;** Pre-penetration; Entry through natural opening; Direct penetration; Entry through wounds, root hairs and buds.

**Unit II. Seed Pathology:** Scope and importance; seed health testing; methods and procedures; Detection of seed borne-fungi, Bacteria and viruses. Seed bio deterioration: Biochemical changes, Morphological abnormalities, loss in germinability. Mycotoxins, fusarium toxin and aflatoxins. Control of Post-harvest spoilage of grains.

**Unit III Toxins of Plant pathogens: Phytotoxins;** Classifications of toxins, Fusaric acid, Lycomarasmin, Pirieularin, Alternaric acid, Tabtoxin, Phaseolotoxin, Victorin

**Unit IV Physiological imbalances in disease plants:** Photosynthesis, respiration, protein metabolism, phenol metabolism, plant growth regulators.

**Unit V. Host Pathogen Interaction**

**i. Disease Resistance in Plants:** Primary infection resistance, Structural and Chemical defences; Post infection resistance: Production and activities of phytotoxins. Histological accumulation of phenols, hypersensitive substances and enzymes, detoxification.

**ii. Genetics of host Pathogen interaction:** Resistance and susceptibility, Vertical and horizontal resistance, Gene for Gene hypothesis, PR-Proteins, physiological specialization, mutation, heterokaryosis.

**Unit V. Disease Management:** Cultural Methods- Avoidance of pathogen, exclusion of inoculum, eradication of pathogen, Chemical methods- sulphur fungicides, Copper fungicides, Mercury fungicides, Quinone fungicides, Systemic fungicides, Antibiotics, Breeding for disease resistance, Integrated Pest Management, Biopesticides and bioagents; *Trichoderma* and VA mycorrhiza. Application of Biotechnology in disease management.

**Practical's Based on Course-BOT 523**

1. Detection of seed borne-fungi and Bacteria.
2. Production and assay of macerating enzymes.
3. Evaluation of fungicide against plant pathogenic fungi.
4. Evaluation of Bioagents against plant pathogenic fungi
5. Evaluation of antibiotics again pathogenic bacteria.
6. Extraction and estimation of pigments in healthy and diseased plants.
7. Estimation of Nucleic acids.

**Suggested readings**

1. Chandnivala, M. (1955). Recent advances in plant pathology, Amol Publication, Pvt. Ltd.,
2. Nurenburg, H.W. (1985) Pollution and their ecotoxicological significance, John Wiley and Sons, New York.
3. Mehrotra, R.S. Plant Pathology, Tata McGraw Hill Publication Co., Ltd., New Delhi.
4. Agriso, G.N. Plant Pathology, Academic Press, New York and London.
5. Bilgrami, K.S. and H.C. Dubey, A text book of Modern plant pathology, Vikas Publishing House, New Delhi.
6. Nene, Y. and P.N. Thaphyal Fungicides in plant disease control II lidiv Oxford and IBH Publishing Co., New Delhi
7. Vyas, S.C. Systemic fungicides, Vol. 1 - 3, Tata Mc(Jrnw Hill Publishing Co., Ltd., New Delhi.
8. Dekker, J. and S.G. Georgopoulos (Ed), Fungicides Resistance in plnnl Protection, CARD Publications,
10. Gangawane, L.V. and Jayashree Deshpande. Pesticides and crop plnntn in India, Ajay Prakashan, Aurangabad.
11. Holton, C.S., Fischr, C.N. Fulton, R.W., Hart, H. and S.K.A.Macallan. Plant Pathology: Problems and progress (1908 - 1958), The University of Wisconsin, USA

**BOT- 523 (Elective C)**

**TAXONOMY OF ANGIOSPERMS-III**

**UNIT-I:** Phylogeny of Angiosperms: Isoetes-monocotyledone theory, Coniferales-amentiferae theory, Gnetales-angiosperms theory, anthostrobilus theory, Bennettitalean theory, Caytonialean theory, Stachyspory-phyllispermae theory, pteridosperm theory, Pentoxylales theory and Durian theory; Co-evolution of insect and plants.

**UNIT-II:** Study of fossil angiosperms: Malvaceae: Sahnio-carpon; Myrtaceae: Sahnipushpam; Soneratiaceae: Sahnianthus, Enigmocarpon; Palmae: Palmoxylon.

**UNIT-III:** Taxonomic tools: Serological and molecular techniques, GIS, GPS, Use of computers in angiosperms taxonomy (Use of computer and data bases for identification of plants with the help of website). Taxonomic keys: suggestions for construction and use of keys: types of keys.

**UNIT-IV: Molecular Biology:** Acquisition of Molecular Data, sources of DNA sequence data, Plant genomes, Polymerase Chain Reaction (PCR) analysis, DNA Sequencing Reaction, Types of DNA Sequence Data, Generation and analysis of DNA Sequence Data, Restriction Fragment Length Polymorphism analysis (RFLP), allozymes, micro-satellite DNA, Random Amplified Polymorphic DNA (RAPDs), Amplified Fragment Length Polymorphism (AFLPs).

**UNIT-V: Numerical Taxonomy:** Principles of taxometrics, operational taxonomic units, taxonomic characters, measuring resemblances, cluster analysis, classification.

**Biosystematics:** Aims, objectives and steps in biosystematic studies, biosystematic categories, importance of biosystematic studies.

**UNIT-VI:** Recent system of classification: Angiosperm Phylogeny Group (APG IV) system.

**UNIT-VII:** Phytogeography: World vegetation, theories of plant distribution, vicarious areas, centres of origin, theory of tolerance.

**Laboratory Exercise based on BOT 523 C**

**TAXONOMY OF ANGIOSPERMS-**

1. Assessment of taxonomic characters (a) analytical and synthetic characters, (b) qualitative and quantitative characters.
2. Study of different taxonomic features (a) stomata, (b) trichomes, (c) crystals, (d) pollen grains.
3. Describing new taxon, deposition of type, Latin diagnosis and abbreviations used in citations.
4. Detection of taxonomically important chemical compounds by various tests.
5. Detection of variations in a given population.
6. Exercises on nomenclature problems: Author citation, principle of priority, transfer of taxa, effective and valid publication etc.
7. Practicals based on numerical taxonomy/ cluster analysis.
8. Study of different types of ovules, placentations and evolutionary trends therein.
9. Study of following fossil angiosperm specimens: Palmoxyton, Enigmocarpon, Sahnianthus, Glossopteris with the help of slides/ specimens.
10. To identify family with the help of computerized Key.
11. Preparation and standardization of some simple Ayurvedic Drugs.

**Suggested Readings:**

1. AHMEDULLAH, M., AND M.P. NAYAR. 1987. Endemic Plants of the Indian Region. Vol. I. Botanical Survey of India. Howrah.
2. BENSON, L.D. 1962. Plant Taxonomy: Methods and Principles. Ronald Press, New York.
3. BHOJWANI, S. S. AND BHATNAGAR, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Dehli.
4. BILGRAMI, K.S. AND J.V. DOGRA. 1990. Phyto Chemistry and Plant Taxonomy. New Delhi, CBS Publishers
5. CRONQUIST, A. 1968. The Evolution and Classification of Flowering Plants. Houghton Mifflin. Boston.
6. CRONQUIST, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
7. CRONQUIST, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.
8. DANIEL, M. 2009. Taxonomy: Evolution at work. Narosa Publishing House Pvt. Ltd. New Delhi.
9. DAVIS, P.H., AND V.H. HEYWOOD. 1965. Principles of Angiosperm Taxonomy. Oliver & Boyd. Edinburgh.
10. DAVIS, P.H., AND V.H. HEYWOOD. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
11. DOBSON, A.P. 1996. Conservation and Biodiversity. Scientific American Library. New York, U.S.A.
12. ERDTMAN, G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Almquist and Wiksell. Stockholm.
13. ERDTMAN, G. 1986. Pollen Morphology and Plant Taxonomy : Angiosperms An Introduction to Palynology. Netherland, E.J.Brill, Leiden.
14. FORMAN, L. AND D. BRIDSON. 1989. The Herbarium Handbook. Royal Botanic Gardens, Kew, U.K.
15. GRAHAM, L.E. 1993. Origin of Land Plants. John Wiley & Sons. Inc. New York.
16. GREUTER, W, (Ed.). 2007. International Code of Botanical Nomenclature. (VIENNA CODE). Koeltz Vesentific Books. Germany.
17. GROOMBRIDGE, B, (Ed.). 1992. Global Biodiversity: Status of The Earth's Living Resources. Chapman and Hall. London.
18. HENRY, A.N., M.CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
19. HESLOP-HARRISON, J. 1953. New Concepts in Flowering Plant Taxonomy. Heinemann Ltd. London.
20. HEYWOOD, V.H. 1967. Plant Taxonomy. Edward Arnold Ltd. Great Britain.
21. HEYWOOD, V.H. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U.K.
22. HUTCHINSON, J. 1973. The Families of Flowering Plants. 3rd Edition. Oxford University Press. Oxford.
23. JAIN, S.K. and R.R. RAO. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.

24. JOHRI, B.M. 1994. Botany in India: History and Progress. Vol-I. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
25. JONES, S.B., AND A.E. LUCHSINGER. 1987. Plant Systematics. 2nd Edition. McGraw-Hill Book Company. New York.
26. JUDD, W. S, C. S. CAMPBELL, E. A, KELLOG, P. F. STEVENS AND N. J. DONOGHUE. 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
27. LAWRENCE, G.H.M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
28. MABBERLEY, D.J. 2005. The Plant-Book, A portable dictionary of the vascular plants. Cambridge University Press, United Kingdom
29. MANILAL, K. S. AND M. S. MUKTESH KUMAR [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
30. MINELLI, A. 1993. Biological Systematics: The State of the Art. London, Chapman & Hall.
31. MONDAL, A.K. 2005. Advanced Plant Taxonomy. New Central Book Agency Pvt. Ltd. Kolkata.
32. MOORE, R., W.D. CLARK, K.R. STERN AND D. VODOPICH. 1995. Botany: Plant Diversity. Wm. C. Brown Publishers. London.
33. NAIK, V. N. 2000. Taxonomy of Angiosperms. Tata McGraw – Hill Publishing Company Limited, New Delhi.
34. Nair, P. K. K. 1966. Pollen morphology of Angiosperms. Periodical Expert Book Agency, New Delhi.
35. NAYAR, M.P., 1996. "Hot Spots" of Endemic plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Thiruvananthapuram, India.
36. NAYAR, M.P., AND R.K. SASTRY. 1987-1990. Red Data Book on Indian Plants. Vols. I - III. Botanical Survey of India. Howrah.
37. QUICKE, D.L.J. 1993. Principles and Techniques of Contemporary Taxonomy. Chapman and Hall. London.
38. RADFORD, A.E., W.C. DICKISON, J.R. MASSEY, AND C.R. BELL. 1974. Vascular Plant Systematics. Harper & Row. New York.
39. RAVEN, P.H., R.F. EVERT, AND S.E. EICHHON. 1992. Biology of Plants. 5th Edition. Worth Publishers. New York.
40. SANTAPAU, H. 1955. Botanical Collector's Manual. Botanical Survey of India.
41. SANTAPAU, H. AND H.A. HENRY. 1994. A dictionary of the flowering plants in India, CSRI, New Delhi.
42. SHARMA A. AND A. SHARMA. 1980. Chromosome Technique: Theory and Practices (3rd ed.) Butterworths, London.
43. SHIVANNA, K. R. AND N. S. RANGASWAMY. 1992. Pollen Biology- A Laboratory Manual. Springer-Verlag
44. SIMPSON, M. G. 2006. Plant Systematics. Elsevier Academic Press, California, USA.
45. SIMPSON, M.G. Plant Systematics. Elsevier Academic Press. Burlington, U.S.A.
46. SINGH, G. 2005. Plant Systematics – Theory and Practice. Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.

47. SIVARAJAN, V.V. 1989. Introduction to Principles of Plant Taxonomy. Oxford and IBH Publishing Co. New Delhi.
48. SOLTIS, D. E., P. S. SOLTIS, P. K. ENDRESS AND M. W. CHASE. 2005. Phylogeny and Evolution of Angiosperms. Sinauer Associates, Inc, Massachusetts, USA.
49. STACE, C.A. 1989. Plant Taxonomy and Biosystematics. Edward Arnold, London.
50. STUESSY, T. F. 2002. Plant Taxonomy. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
51. SUBRAMANIAM, N.S. 1995. Modern Plant Taxonomy. Vikas Publishing House. New Delhi.
52. TAKHTAJAN, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendra pal Singh, Dehra Dun, India.
53. TAYLOR, D. V. AND L. J. HICKEY. 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributors, New Delhi.
54. WILEY, E.O. 1981. Phylogenetics : The Theory and Practice of Phylogenetic Systematics. New York, John Wiley & Sons.

**BOT 523 (Elective D)**

**Plant Physiology – III**

**Unit I. Plant water relations:** molecular structure of. water, water potential, Absorption of water by land plants, transpiration and its significance, physiology of stomatal movements, anti-transpirants.

**Unit II. Stress physiology:** Biotic and abiotic environmental stresses, effect on plant metabolism and growth, high temperature stress, water stress, chilling stress, thermogenesis, salinity and salt stress, salt respiration, salinity and agriculture.

**Unit III.** Seed germination, seedling growth, seed dormancy, light and temperature sensitive seeds, Biochemical changes associated with seed germination, Hormonal regulation, conditions for seed germination, Mobilization of reserve food material, longevity of seed and seed viability.

**Unit IV.** Organic farming, mixed fanning, crop rotation and inter-cropping, weed management and control, Herbicides, weed biomass as green manure, organic matter recycling and preparation of compost / vermicompost, Production of crop plants under organic and conventional fanning system, Bio-fertilizers, Bio-methylation

**Unit V.** Productivity of crop plants, integrated fertilizer management, bio-fertilizers, productivity

potential and cultural practices for fiber plants (e.g. cotton), cereals (rice, wheat), millets (Sorghum, pearl millet), pulses (gram), oil seed crops (safflower, groundnut), commercial crops (sugarcane), vegetables, fodder crops (Lucerne, hybrid Napier, maize).

**Unit VI.** Role of nucleic acids as carriers of genetic Information, transformation and transduction. Auto catalytic function of DNA-replication, Hetero catalytic functions - Transcription and translation, totipotency, differential gene activity and its regulation. Gene technology, Recombinant DNA, GM plants, Application of Gene technology in agriculture,

**Laboratory Exercise Based on BOT- 523 (Elective D):**

1. Determination of water potential.
2. Effect of growth regulators on seed germination.
3. Estimation of starch in fresh, germinating and germinated seed.
4. Estimation of glucose at various stage of seed germination.
5. Estimation of protein content during seed germination – Lawry's method, burette method
6. Estimation of non-protein nitrogen (NPN) content in germinating seeds,



7. Estimation of vitamin C in germinating seeds.
8. Determination of seed viability.
- 9) Effect of PGRs on senescence.
- 10) Chemical changes associated with fruit ripening.
- 11) Estimation of the activities of hydrolytic enzymes - amylase, lipase, protease, cellulose etc.
- 12) Chlorophyll content in crop plants\*
- 13) Estimation of fat content in seeds,
- 14) Estimation of starch in seeds.

**Suggested Reading:**

1. Mukharji S and A.K. Ghosh. Plant Physiology - New Central Book Agency, Kolkatta.
2. Mertz, E.T. Elements Biochemistry Vakils, Fe Her and SimsonPvt Ltd, Bombay.
3. Fains, J.L. and Kilgour, G.L. Essentials of Biological Chemistry, Affiliated East - West Press, Pvt. Ltd., New Delhi.
4. Moat, A.G., Foster, J.W. and Spectok, M.P. Microbial Physiology, WileysLiss, A. John Wiley and Sons, Inc., Singapore.
5. Trevan, M.D., Botey, S., Goulding, K.H. and Stanburn, P. Biotechnology. The Biological principles. Tata Me Crow Hill Publishing Company Limited, New Delhi.
6. Salisbury. I. B. and Ross. C.W., Plant Physiology CBS Publishers and Distributors, New Delhi.
7. Noggle, G.R. and Fritz, G.S. Introductory Plant Physiology. Printice Hall, USA.
8. Styter, R.O. Plant water relationship, Academic Press, New York.
9. Hess, D. Plant Physiology, Narosa Publishing House, New Delhi.
10. Devlin, R.M. and Hostan, F.H. Plant Physiology, CBS publishers and Distributors, New Delhi.
11. Mukharji, S. and Ghosh A.K. Plant Physiology, Tata Me Graw Hill Publishing Company Ltd., New Delhi.
12. Datta, C.S. Plant Physiology, Wiley Eastern Limited, New Age International Ltd., New Delhi.
13. Vaidya, V.G., Sahasrabudhe, K.R. and Khupse, V.S. Crop production and field experimentation, Continental Prakashan, Pune - 30.

**SERVICE COURSE-2**  
**BOT 524 MEDICINAL PLANTS**

**Unit I Introduction of Systems of Medicines-** a) Ayurved b) Siddha d) Unani e) Chinese f) Naturopathy g) Homeopathy.

**Unit II a)** Health Concept in Ayurved, **b)** Dincharya and Rutucharya  
c) Anupan d) Pathya and Apathy e) Viruddha Ahaar.

**Unit III Classification of Drugs:**

**a) Root drugs:** *Withania somnifera* (L) Dunal, *Asparagus racemosus* Willd. *Chlorophytum borivillianum*, *Vetiveria zizanoides* ( 1.) Nash, *Glycirrhiza glabra*

**b) Rhizome drugs:** *Zingiber officinale* Rose, *Curcuma longa* L., *Acorus calamus*L.

**c) Stem and wood drugs:** *Tinospora cordifolia* (Willd.) Miers, *Santalum album* L,  
*Pterocarpus marsupium* Roxb., *Pterocarpus santalinus*

**d) Bark drugs:** *Terminalia cuneata* Roth, *Crateva adansonii* DC subsp. *Odora* ( Buch.-Ham.) Jacobs, *Acacia nilotica*( L.) Del, *Azadirachta indica*A. Juss.,

**e) Leaf drugs:** *Aloe vera*(L.) Burm.f, *Adhatoda zeylanica* Medic., *Cymbopogon citratus*, *Kalanchoe pinnata*(Lamk.) Pers. *Mentha* sp.

**f) Flower drugs:** *Syzigium aromaticum*, *Crocus sativus*

**g) Fruit drugs:** *Emblica officinale*, *Terminalia bellirica* (Gaertner) Roxb., *T. Chebula* (Gaertner) Retz *Aegle marmelos*(L) Corr.

**h) Seed drugs:** *Syzigium cumini*(L.) Skeel, *Celastrus paniculatus* Willd.,  
*Semecarpus anacardium* L. f

**i) Entire plant drugs:** *Ocimum tenuiflorum* L, *Bacopa monnieri* (L.) Penn,

**Unit IV a)** Identification of Medicinal Plants

b) Harvesting, Storage and preservation of Medicinal plants

**Unit V Introduction of formulations of some Ayurvedic drugs:** a) Asava and Arishta, b) Churna c) Vati and ghutid) Aark e) Pak and Avaleha f) Fant and Kadha  
g) Satva h) Tailam and ghritam

**Suggested Readings:**

1. Anonymous 2000, "The Ayurvedic Formulary of India" - Part - II, Govt. Of India Publication, New Delhi.
2. Daniel, M. 2006, "Medicinal Plants - Chemistry and Properties" Oxford & IBM Publishing Co. Pvt. Ltd. New Delhi.
3. Desai W. G. 1975, "*AushadhiSangraha*" Rajesh Publication, Pune.
4. Garde G. K. 2009, (Revised Edition) "*Sort/7 Vagbhat - Ashtanghridayam*", Rajesh Publication, Pune.
5. Jain S. K. 1991, "Dictionary of Indian Folk Medicine and Ethnobotany" Deep Publication, New Delhi.
6. Kameshwara Rao C. 2000, "Material for the Database of Medicinal Plants" Karnataka state Council for Science and Technology for the Department of Forests, Environment and Ecology, Govt of Karnataka Publication.
7. Kirtikar K. R. and Basu B. D. 2001 (Reprint) "Indian Medicinal Plants" Oriental enterprises Uttaranchal.
8. Manilal K. S. 2001, "Van Rheed's Hortus Malabaricus" English Edition. University of Kerala Publication.
9. Nadkarni K. M. 1976, (Revised Edition) "Indian Materia Medica" Popular Prakashan, Mumbai.
10. Sharma O. P. 1996, "Hills Economic Botany" Tata McGraw Hill Publication, New Delhi.
11. Yoganarasimhan S. N. 1996, "Medicinal Plants of India" vol. I. Karnataka. Interline Publication Pvt. Ltd. Bangalore.
12. Anonymous, "*Upchar Paddhati aur Pathya*" Baidyanath Publication.
13. Anonymous, "*Vividh Upcharpaddhati*".....