Sri Dev Suman Uttarakhand University Badshahithaul Tehri Garhwal
Syllabus of Botany Course for B.Sc. (6 Semesters)

B.Sc. Botany Syllabus

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Botany and their applications, the syllabus pertaining to B.Sc. (3 Year Degree Course) in the subject of Botany has been proposed as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit-wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

B.Sc. Semester I

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Microbiology	BBO101	80	20
II	Fungi, Elementary Plant Pathology and Lichens	BBO102	80	20
	Lab Course I	BBO10P	40	10

B.Sc. Semester II

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Algae and Bryophyta	BBO201	80	20
II	Pteridophyta, Gymnosperm and Elementary Palaeobotany	BBO202	80	20
	Lab Course II	BBO20P	40	10

B.Sc. Semester III

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Taxonomy of Angiosperms	BBO301	80	20
II	Anatomy and Embryology	BBO302	80	20
	Lab Course III	BBO30P	40	10

B.Sc. Semester IV

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Cytology and Genetics	BBO401	80	20
II	Plant Ecology	BBO402	80	20
	Lab Course IV	BBO40P	40	10

B.Sc. Semester V

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Molecular Biology and Biotechnology	BBO501	80	20
II	Plant Breeding and Biostatistics	BBO502	80	20
	Lab Course V	BBO50P	40	10

B.Sc. Semester VI

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Plant Physiology, Elementary Morphogenesis and Biochemistry	BBO601	80	20
II	Economic Botany and Biodiversity	BBO602	80	20
	Lab Course VI	BBO60P	40	10

Semester I (90 Lectures)

Paper I (BBO 101): Microbiology

UNIT-I — **10 Lectures**

1. History and scope of Microbiology.
2. A brief idea of microbial diversity and distribution, position of microorganisms in the living world
3. Classification of microorganisms.

UNIT-II — **08 Lectures**

1. Elementary principles and methods of isolation, purification and culture of microorganisms (bacteria and Fungi)
2. Role of microorganisms in biogeochemical cycles in nature.
3. Bacteria: Structure, reproduction, nutrition, plasmids, economic importance.

UNIT-III — **08 Lectures**

1. Virus: general characteristics, structure, replication, transmission.
2. A brief idea of bacteriophages, cyanophages

UNIT-IV — **06 Lectures**

1. Viroids and prions.
2. Mycoplasma: a general account.

Paper II (BBO 102): Fungi, Elementary Plant Pathology and Lichens

UNIT-I: **14 Lectures**

1. Brief history and salient features of fungi
2. Outline of classification of Alexopoulos & Mims and salient features of important groups.
3. Habit, habitat, structure and methods of reproduction of fungi based on the following representatives. *Albugo, Mucor, Saccharomyces, Puccinia and Alternaria.*

UNIT-II: **16 Lectures**

1. Lichens: Occurrence. General structure, types and physiology (symbiotic relationship) of Lichens.
2. Morphology and microscopic structure of crustose, fruiticose and foliose lichens
3. Economic importance of Lichens in general.

UNIT-III: **12 Lectures**

1. General symptoms of plant diseases.
2. General principles of infection and resistance.

UNIT-IV: **16 Lectures**

1. General methods of chemical and biological control of the plant diseases.
2. The symptoms, morphology of the causal organism, disease cycle and control measures of the following disease: White rust of crucifers, Loose smut of wheat, , Wart disease of potato, Red rot of sugarcane.

Lab Course (BBO 10P):

1. Study of various equipments, glasswares and accessories used in microbiological experiments.
2. Preparation of bacterial and fungal culture media.
3. Negative staining and Staining of bacteria with Gram stain.
4. A study of the following types: *Albugo,Mucor, Agaricus, Alternaria, Ustilago and Puccinia*
5. Study of morphology and structure of different types of lichens
6. Symptoms and morphology of diseases, as mentioned in theory syllabus.

Books recommended:

Gangulee, H.C. and Kar, A.K. 1992. College Botany, Vol II. Calcutta
Pandey, B.P. 1999. Simplified Course in Botany, B.Sc. I S. Chand & Co. Ltd. New Delhi
Singh, V., Pande, P.C. and Jain, D.K. 1998. A Text Book of Botany, Rastogi Publ, Meerut
Singh, R.S. 1992. Principles of Plant Pathology. Oxford and IBH Publ. Co., New Delhi.
Vashistha, B.R. 1998. A Texthook of Fungi. S. Chand & Co. New Delhi
Sharma, P.D., Microbiology. Rastogi Publications, Meerut, India

Dubey, R.C., & D.K. Maheshwari. A textbook of Microbiology. A.Chand& Company, New Delhi
Clifton, A. 1958. Introduction to the Bacteria. McGraw-Hill book Co., New York.
Mandahar, C.L. 1978. Introduction to Plant Viruses. Chand & Co. Ltd., Delhi.
Dubey, R.C. & D.K. Maheshwari. Practical Microbiology. S.Chand, New Delhi
Aneja, A.R. Experiments in Microbiology Plant Pathology and Biotechnology. New Age International Publishers
Kaushik, P 2009. Introductory Microbiology. Emkay Publication, Delhi, 110051.

Semester II : 90 Lectures

PAPER I (BBO 201): Algae and Bryophytes

UNIT-I: **12 Lectures**

1. General Characteristics of Algae
2. Classification of algae, basic outline of Fritsch's classification
3. Organization of thallus, pigmentation and mode of reproduction in Algae

UNIT-II: **12 Lectures**

1. Occurrence, structure of thallus and mode of reproduction in the following genera: *Chlamydomonas, Cladophora, Vaucheria and Chara*
2. General account of the Bacillariophyceae

UNIT-III: **10 Lectures**

1. Occurrence, structure and mode of reproduction of the *Polysiphonia.*
2. Cyanobacteria- A general account and nitrogen fixation by cyanobacteria
3. Economic importance of algae as food and fodder, in agriculture, industry and in public health

UNIT-IV: **12 Lectures**

1. Outline and basic principles of classification of the Bryophytes
2. Comparative account of the gross morphology, vegetative and sexual reproduction, structure and evolution of the sporophytes of *Marchantia, Anthoceros and Funaria.*
3. Origin, habitat, distribution and economic importance of Bryophytes

PAPER II (BBO 202) : Pteridophyta, Gymnosperm and Elementary Palaeobotany

UNIT-I: **18 Lectures**

1. General characters of the Pteridophytes and classification as proposed by Sporne.
2. A comparative study of *Rhynia, Selaginella, Equisetum* & *Marsilea* on the basis of following features:

Morphology and anatomy of the vegetative plant body and spore producing organ (strobilus, sporophyll, sporoangium and spores), sexual reproduction; male and female gametophytes, fertilization.

UNIT-II: **8 Lectures**

1. A brief account of Telome theory, Stelar system and its evolution.
2. Heterospory and seed habit in Pteriklophytes.

UNIT-III: **12 Lectures**

1. Outlines of classifications as proposed by D.D. Pant and distinguishing features of Gymnosperms. Distribution of Gymnosperms in India.
2. Comparative account of the structure, life history and evolutionary trends and economic importance based on *Cycas and Pinus* and *Ephedra*.

UNIT-IV: **6 Lectures**

1. Process of fossilization
2. Types of fossils
3. Living and pseudo-fossils.

Lab Course (BBO 20P)

Study of the following types by preparing temporary slides: *Nostoc, Chlamydomonas, Cladophora, Vaucheria, Chara, Sargassum and Polysiphonia*
Study of the external features and internal structures with the help of permanent and/or temporary preparation of scales, rhizoids, gemma cups, archegoniophores, antheridiophores and sporophytes of the following: *Riccia, Marchantia, Anthoceros and Funaria.*
Study of the external features and internal structures of rhizomic, leaves, roots, and reproductive structure of *Selaginella, Equisetum and Marsilea* (Specimen and Permanent Slides only)
Study of the morphological features and anatomical structures of vegetative and reproductive parts of *Cycas, Pinus*(Specimen and Permanent Slides only).
Study of fossil specimens.

Books recommended:

Algae and Bryophyta

Khan, M. 1983. Fundamentals of Phycology. Bishen Singh Mahendra Pal Singh, Dehradun.
Parihar, N.S. 1976. The Biology and Morphology of Bryophytes. Central Book Depot, Allahabad.
Puri, P. 1980. Bryophytes. Atma Ram & Sons, Delhi.
Sharma, O.P. 1998. A Text Book of Bryophyta. Pragati Prakashan, Meerut.
Singh, V., Pandey, P.C. and Jain, D.K. 1996. A Textbook of Botany, Rastogi Publ, Meerut.
Vasishta, B.R. 2001. Text Book of Algae. S. Chand & Co. New Delhi.
Rashid, 1996. Pteridophyta
Parihar, N.S. 1996. Biology & Morphology of Pteridophytes. Central Book Depot, Allahabad.
Pandey, S.N. A Textbook of Pteridophyta.
Singh, V., Pandey, P.C. and Jain, D.K. 1996. A Textbook of Botany, Rastogi Publ. Meerut.
Pandey, B.P. 2001. Gymnosperms and Palaeobotany. S. Chand & Co. ltd., New Delhi

Sharma, O.P. 1998. An Introduction to Gymnosperms, Pragati Prakashan, Meerut.
Vashistha, P.C. 2001. A Textbook of Pteridophyta, S. Chand & Co. Ltd., New Delhi
Vashistha, P.C. 2001. A Textbook of Gymnosperm, S. Chand & Co. Ltd., New Delhi

Semester III : 90 Lectures

Paper I(BBO 301) : Taxonomy of Angiosperms

UNIT-I: **14 Lectures**

1. Origin of Angiosperms: Vavilov's concept, some examples of primitive angiosperms. Angiosperm taxonomy- fundamental taxonomical characteristics.
2. Historical development in plant taxonomy in pre- Linnaeus and post Linnaeus periods.
3. Comparison and evolution of the systems of classification as proposed by Linnaeus, Bentham and Hooker and Hutchinson

UNIT-II: **12 Lectures**

1. Nomenclature: International Code of Nomenclature for Algae, Fungi and Plants (ICN), scientific naming of plants , priority, types, validity, *nomina conservanda*
2. Collection and preservation techniques of specimens for herbarium and museum.
3. Botanical Gardens and Herbaria. A brief idea of Botanical Survey of India (BSI)

UNIT-III: **10 Lectures**

1. Taxonomy, important distinguishing characters, classification and economic importance of the following families:
   a. A. *Dicotyledonae*
   Polypetalae: Ranunculaceae, Papaveraceae, Caryophyllaceae, Malvaceae, Rutaceae, Fabaceae, Rosaceae, Cucurbitaceae, Apiaceae.

UNIT-IV: **10 Lectures**

1. *Gamopetalae*: Solanaceae, Apocynaceae, Asclepiadaceae, Acanthaceae, Lamiaceae
2. *Monochlamydae*: Euphorbiaceae, Moraceae
3. *Monocotyledonae*: Orchidaceae, Poaceae

Paper II(BBO 302) : Anatomy and Embryology

UNIT-I: **8 Lectures**

1. The techniques for the study of plant anatomy
2. Meristems- Primary and Secondary meristems, characteristics and functions. Various types of permanent tissues
3. Anatomy of stem, root, leaf (Dicot & monocot)

UNIT-II: **12 Lectures**

1. Secretory structures
2. Structure of xylem and phloem including cork cambium, its activity and products.
3. Origin, structure and function of vascular cambium, anomalous secondary growth with special reference to the following taxa: *Salvadora, Dracaena, and Tinospora* and

Velamen in Orchid and *Ficus*

UNIT-III: **12 Lectures**

1. Structure of anther, microsporogenesis and development of male gametophytes in angiosperms
2. Structure of ovule, megasporogenesis and development of different types of female gametophytes.
3. Mode of different types of Pollination, double fertilization and triple fusion.

UNIT-IV: **12 Lectures**

1. Types of endosperm and embryo development in dicots.
2. Polyembryony and apomixis
3. Seed germination and dormancy

Lab Course (BBO 30P)

Identification of locally available plants belonging to the families mentioned in the syllabus, their description in semi technical language

Collection of the plant specimens-herbarium and/or live specimen. Excursion should be organized by the department to acquaint the students with the local flora.

Demonstration of usual techniques of plant anatomy, section cutting. TS. LS of leaf, stem and root.

Normal and abnormal secondary growth in *Boerhavia, Salvadora, Dracaena, Ficus, and Tinospora*

T.S. of Anther

Study of various types of pollen grains, placentations, embryosacs, ovules and stages of embryo development using permanent preparations.

Demonstration of pollen germination experiment using hanging drop or other method.

Books recommended:

Agrawal, K.C. 1999. Biodiversity. Agrobotanica, Bikaner.

Gupta, R.K. 1989. Text Book of Systematic Botany. Atma Ram & Sons, New Delhi.

Pandey, B.P. 2001. a Text Book of Angiosperms. S. Chand & Co. Ltd., New Delhi.

Saxena, N.B. 1997. Plant Taxonomy. Pragati Prakashan, Meerut.

Singh, V. and Jain, D.K. 1998. Taxonomy of Angiosperms, Restogi Publ., Meerut.

Tyagi, Y.D. & Ksheterpal, S. 1996. An Introduction to the Taxonomy of Angiosperms. Ramesh Book Depot. Jaipur.

Vasudeven, R. Taxonomy of Angiosperms

Bhojwani, S.S. and S.P. Bhatnagar. 1994. Embryology of Angiosperms

Maheshwari, P. An Introduction to Embryology of Angiosperms

Singh, S.P. A Textbook of Plant Anatomy

Tayal, M.S. 1996. Plant Anatomy. Rastogi Publ., Meerut.

Semester IV : 90 Lectures

Paper I(BBO 401) : Cytology and Genetics

UNIT-I **10 Lectures**

1. Cell structure: Prokaryotic and eukaryotic cells; ultrastructure of eukaryotic cell,
2. Cell wall and plasma membrane (ultrastructure, chemical composition and models of plasma membrane)
3. Structure and Function of Nucleus: Ultrastructure, Nuclear membrane, Nucleolus

UNIT II **8 Lectures**

1. Structure and Function of cell Organelles: Vacuoles, Lysosomes, Mitochondria, Chloroplasts,
2. Cell cycle and Cell Division (Mitosis and Meiosis), Their comparison
3. Linkage and Crossing over

UNIT-III **10 Lectures**

1. Mendel's Laws of inheritance (Law of dominance, Law of segregation and Independent assortment, Incomplete dominance)
2. Cytoplasmic inheritance
3. Interaction of Genes

UNIT-IV **10 Lectures**

1. Sex-linked inheritance, Haemophilia, Colour Blindness,
2. Determination of sex
3. Mutation

Paper II (BBO 402) : Plant Ecology

UNIT-I: **12 Lectures**

1. Definition and scope of Ecology
2. Ecosystem: Types, abiotic and biotic components, food chain, food web and ecological pyramids,
3. Energy flow and ecological energetics, Lindemann's Concept of energy flow,

UNIT-II: **12 Lectures**

1. Biogeochemical cycles: A brief discussion of concept by giving examples of carbon and nitrogen cycles.
2. Population ecology: Definition, population characters

3. Community ecology: Community characteristics, structure and composition, quantitative, qualitative and synthetic features, life forms and biological spectrum.

UNIT-III: **14 Lectures**

1. Productivity, type, measurement of primary productivity , turn over,
2. ecological succession
3. Bio-geographical regions of India; vegetation types in Uttarakhand.

UNIT-IV: **14 Lectures**

1. Applied ecology : Soil erosion and soil conservation,
2. Pollution of air and water, Thermal and radioactive pollution, Prevention and control of pollution.
3. Global warming, ozone depletion and climate change.

Lab Course (BBO 40P):

Study of Cell division Mitosis and Meiosis using smear and squash technique
Problems based on mendel's law and incomplete dominance
To determine the minimum size of quadrate by species area curve method
To determine the minimum number of quadrate to be laid down for the vegetational analysis of the given area
To determine frequency, density and abundance of each species in a community by quadrate method
To prepare frequency diagrame and compare it with that of the Raunkier's normal frequency diagrame
To determine the main basal cover and total basal cover.
To study the physical character of the soil in terms of temperature, colour texture and pH
To find out the bulk density and porosity of different soil samples.
To estimate the moisture percentage of various soil samples

Books recommended:

Gupta, P.K. 2000. Cytology, Genetics and Evolution, Rastogi Publications, Meerut.
Gupta, P.K. 2000. Genetics, Rastogi Publications, Meerut.
Gupta, P K. 2001. Elements of Biotechnology. Rastogi Publication, Meerut.
Power, C.B. 1994. Cell Biology. Himalaya Publishing House, Delhi.
Veerbala Rastogi Introductory Cytology. Meerut. Ambasht, R.S. 1992. A Text Book of Plant Ecology, Students Friends & Co. Varanasi.
Jasra, P.K. and Gurudeep Raj. 2000 Biostatistics, Krishna Prakashan Media (P) Ltd. Meerut.
Misra, K.C. 1980. Manual of Plant Ecology. Oxford and IBH Publ. Co. New Delhi.
Odum, E.P 1983. Basic Ecology. Sounders College Publ, New York.
Ray, M. & Sharma, H.S. 2000. Mathematical Statistics, Ram Prasad & Sons. Agra.
Sharma, P.D. 2001. Ecology and Environment, New Delhi.

Semester V : 90 Lectures

Paper I (BBO 501): Molecular Biology and Biotechnology

UNIT I

14 Lectures

1. DNA as genetic material : Griffith and Avery Transformation experiment, Harshy and Chase bacteriophage experiment
2. Watson and Crick Model of DNA, Replication of DNA (Semi conservative)
3. Types of RNA (tRNA, rRNA and mRNA) their structure and function.

UNIT II

14 Lectures

1. Eukaryotic chromosome: structure, chemical composition, Karyotype analysis.
2. Ideogram; structure and functions of Polytene and Lampbrush chromosomes

UNIT-III

12 Lectures

1. Definition and scope of biotechnology
2. Theory and techniques of plant tissue culture, storage of germplasm (cryopreservation)
3. Biology of *Agrobacterium*, vectors for gene delivery and marker genes.

UNIT-IV

14 Lectures

1. Genetic Engineering: Tools and techniques of recombinant DNA technology, cloning vectors, genome and cDNA libraries, transposable elements,
2. Techniques of gene mapping and chromosome walking,
3. Gene Sequencing

Paper II (BBO 502): Plant Breeding and Biostatistics

UNIT-I:

12 Lectures

1. Plant breeding : Aims and objectives, basic techniques of plant breeding
2. Crop improvement method- Plant introduction, selection, acclimatization and hybridization.
3. Mutational breeding and breeding for disease resistance

UNIT-II:

6 Lectures

1. Improved seeds – production, multiplication and distribution.
2. Maintenance and seed testing
3. National Seeds Corporation and Seed Testing Laboratories.

UNIT-III:

10 Lectures

1. Method s of representation of statistical data diagrams.
2. Measurements of central tendencies – Mean, Median, Mode.

3. Measures of dispersion – range, mean deviation and standard deviation.

UNIT-IV:

1. Coefficient of correlation. **8 Lectures**
2. Test of significance-Chi-square test.

Lab Course (BBO 50P):

Study of biotechnological tools and equipments.
Preparation of culture media for plant tissue culture.
Isolation, surface sterilization and inoculation of explants.
Isolation of plant protoplasts.
Preparation of artificial seeds.
Perform the Emasculation in the plant provided.
Determine the Dockage percentage
Determination of Moisture percentage in the soil samples provided.
Study of the Floral Biology of some important plants
Statistical problems of central tendencies, standard deviation, correlation and chi-square test

Books recommended:

Gupta, P.K. 2000. Genetics, Rastogi Publications, Meerut.
Gupta, P.K. 2001. Elements of Biotechnology. Rastogi Publication, Meerut.
Dubey, R.C. 2000. A Text Book of Biotechnology. S.Chand & Company, New Delhi
Aneja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age Publication, New Delhi
Chaudhary, H.K. Plant Breeding
Bhandari, M.M. 1979. Practicals in Plant Breeding. Oxford and IBH Publ. Co. New Delhi.
Kapoor, R.L. Plant Breeding and Crop Improvement
Kochhar, S.L. Economic Botany in the Tropics.
Simmonds, N.W. 1988. Evolution of Crop Plants.
Singh, B.D. 2001. Plant Breeding-Principles and Methods. Kalyani Publ. New Delhi.

Semester VI : 90 Lectures

Paper I(BBO 601) : Plant Physiology, Elementary Morphogenesis and Biochemistry

UNIT-I **8 Lectures**

1. Cell Physiology, diffusion, permeability, plasmolysis, imbibition, water potential and osmotic potential
2. Active and passive absorption, anatomical features of xylem in relation to path of water transport, ascent of sap.
3. Loss of water from plants, transpiration, factors affecting transpiration, guttation, anatomy of leaf with special reference to loss of water

UNIT-II **12 Lectures**

1. Translocation of solutes, theories and mechanism of translocation, anatomical features of the phloem tissue with reference to the translocation of solutes.
2. Elementary knowledge of the macro and micronutrients.
3. Symptoms of mineral deficiency; techniques of water and sand culture

UNIT-III **14 Lectures**

1. Photosynthesis, historical background and importance of the process, role of primary pigments, Concept of two photosystems, Z-scheme, Photophosphorylation, calvin cycle, Factors affecting photosynthesis, chemosynthesis.
2. Respiration, glycolysis, Kreb's cycle, Electron transport mechanism (Chemiosmotic theory), ATP the biological energy currency, Redox potential, oxidative phosphorylation, pentose phosphate pathways, CAM plant, factors affecting respiration, fermentation.

UNIT-IV **14 Lectures**

1. Carbohydrates- properties, structures and biological role.
2. Structures and properties of Proteins.
3. Plant growth regulators, Auxin, cytokinins and Abscissic acid
4. Morphogenesis: basic concept of differentiation, morphogenesis, polarity and totipotency, Elementary Plant Movements

Paper II(BBO 602): Economic Botany and Biodiversity

UNIT-I **4 Lectures**

1. Importance of plants to mankind
2. Origin of cultivated plants, centres of origin of some important crop plants.

UNIT-II **12 Lectures**

1. Origin, history, botanical features and cultivation of wheat, maize and one millet.
2. Legumes- an introduction to the economically important legumes.
3. Oils- Caster oil, linseed oil, mustard oil and mint oil.
4. Sugar and starches (sugar cane)

UNIT-III **14 Lectures**

1. General account of fruit (apple, banana, citrus, litchi and mango) and vegetable (root, stem, leaf and fruit vegetable) plants
2. Fibers (Coir, cotton, flax, hemp) and medicinal plants (*Aconitum, Atropa, Cinchona, Ephedra and Rauwolfia*) plants
3. Common timber yielding plants (*Chir, deodar, sal, shisham and teak*) of western Himalaya
4. Beverages – Tea, coffee and alcohol beverages

UNIT-IV: **12 Lectures**

1. Biodiversity: Basic concept, biodiversity at global and National level, causes of loss of Biodiversity
2. Biodiversity conservation: action plan: In situ and Ex-situ conservation, gene bank, introductory account of Biosphere Reserves, national Parks and sanctuaries.

Lab Course (BBO 60P) :

1. Study the path of conduction of water by eosin method
2. Respiratory quotient by Respirometer
3. Estimation of Rate of photosynthesis
4. Rate of transperation by Ganong's potometer
5. Perform the experiments on Osmosis & plasmolysis
6. Comparison of stomatal & cuticular transpiration
7. Experiments on Paper chromatography, Separation of pigments.
8. Experiments based on use of growth regulators in plants
9. Study of economic importance of Food Crops, Legumes, Oil yielding plants, fruits and vegetable plants
10. Study of Timber & fire wood yielding plants
11. Study of Fibre yielding & Medicinal Plants
12. Plant based Beverages & Sugars

Recommended Books:

Devlin, R.M. 1996. Plant Physiology, Indian Print, New Delhi
Kochhar, P.L. and H.B. Krishnamoorthy, 1998. Plant Physiology.
Pandey, S.N. 2000. Plant Physiology.
Srivastva, H.S. 2001. Plant Physiology, Rastogi Publications, Meerut.
Verma, S.K. 1996. A Textbook of Plant Physiology.
Zeiger and Tez. 2010. Plant Physiology and Biochemistry
Plant Wealth of India 1997. Special Issue of Proceedings Indian National science Academy 8-63.
Pluckneu, D.L., Smith, N.J.H., William, J.T. and Murti Annishetty, N. 1987. Gene Banks and worlds Food. Princeton University Press, Princeton, New Jersey, USA.
Rodgers, N.A. and Panwar, H.S. 1988. Planning a Wildlife Protected Area Network in India. Vol. 1 The Report. Wildlife Institute of India, Dehradun.
Sahni, K.C.2000. The Book of Indian Trees, 2nd edition. Oxford University Press Mumbai.
Schery, R.W. 1972. Plants for Man. 2nd ed. Englewood Cliffs, New Jersey, Prentice Hall.
Sharma, O.P. 1996. Hill's economic Botany (Lata Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd., new Delhi.
Swaminathan, M.S. and Koochar, S.L. (Eds) 1989. Plants and Society. Macmillan Publication Ltd., London.
Thakur, R.S., Puri, H.S. and Husain, A. 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.

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