

# DEPARTMENT OF BOTANY

## UNIVERSITY OF KASHMIR, SRINAGAR

The revised curriculum is to be adopted for B. Sc 1<sup>st</sup> year from the academic session 2012 and subsequently for B. Sc 2<sup>nd</sup> and B. Sc 3<sup>rd</sup> year.

**Course Structure:** The course will comprise of 6 papers, two papers in each year to be named as Paper “A” and Paper “B”. Each paper will be of 50 marks and 2½ hours duration. For each year there will be one practical course (L-01 in B. Sc 1<sup>st</sup> year, L-02 in B. Sc 2<sup>nd</sup> year and L-03 in B. Sc 3<sup>rd</sup> year) worth 50 marks and 3 hours duration. Out of 50 marks, 25 will be for internal assessment and 25 for external examination. Students will have to submit their practical note books as well as a plant collection herbarium at the time of practical examination (with 5 marks given to both).

**Botanical Trips:** To make on-field observations and impart on-site training in the subject botany, the colleges will ensure that a minimum of one field trip is organized for each class during the academic session to acquaint the students with the flora of the region and also to collect and prepare 10 plant specimens following standard herbarium techniques. The students will, however, avoid collection of rare and threatened plant species.

The marks distribution for external practical examination will be as: Practical: 15 marks, Herbarium, prepared slides/note book/ viva voce: 10 marks.

### INSTRUCTIONS FOR PAPER SETTERS

The question paper in each theory paper (course) shall contain three sections as detailed below:

**Section A:** It will include one question consisting of very short answer type eight parts, each part to be answered in about 20 words. Two parts will be set each section. The candidate will be required to attempt all the questions. Weightage shall be 20% of total marks.

**Section B.** It will consist of four short answer type questions, each to be answered in about 250 words. One question will be set from each unit and the candidate shall be required to attempt all the questions. Weightage shall be 40% of total marks.

**Section C:** It will consist of four long type questions, each to be answered in about 500 words. One question will be set from each unit and the candidate shall be required to attempt any two questions. Weightage shall be 40% of total marks.

**B. Sc 1<sup>st</sup> year****Botany A: Diversity of Microbes and Cryptogams****Unit: 1**

- i. Diversity of Microbes:** A general outline of various types of microbes.
- ii. Viruses:** Structure with special reference to TMV, T-2 phage, lytic and lysogenic cycles, economic importance; mycoplasma--general account; viroids and prions.
- iii. Bacteria and Cyanobacteria:** Bacteria—overview of structure, Gram positive and Gram negative bacteria; General characters of Cyanobacteria with special reference to *Nostoc*.
- iv. Fungi:** General characteristics, classification proposed by Alexopoulos and Mims (1973); General characters of following groups of fungi and life cycle of representative types shown against each group.
 

<b>Oomycetes</b>	<i>Phytophthora</i>
<b>Ascomycetes</b>	<i>Morchella</i>
<b>Basidiomycetes</b>	<i>Agaricus</i>
<b>Deuteromycetes</b>	<i>Alternaria</i>
- v. Plant Pathology:** Symptoms, etiology and management of black stem rust and powdery mildew of apple.

**Unit- II**

- vi. Lichens:** General characters and types.
- vii. Algae:** General characteristics; criteria for algal classification; Round's system of classification; general characters of following groups of algae and life cycle of representative types shown against each group.
 

<b>Chlorophyceae</b>	<i>Chlorella</i>
<b>Xanthophyceae</b>	<i>Vaucheria</i>
<b>Rhodophyceae</b>	<i>Batrachospermum</i>
<b>Phaeophyceae</b>	<i>Ectocarpus</i>
- viii. Economic importance** of algae with special emphasis on algal blooms, indicators of pollution, algae as alternate source of energy.

**Unit- III**

- ix. Bryophytes:** General characteristics; Proskauer's (1957) system of classification.
- x.** General characters of following groups of bryophytes and life cycle of representative types shown against each group:
 

Hepaticopsida	<i>Marchantia</i>
Anthocerotopsida	<i>Anthoceros</i>
Bryopsida	<i>Polytrichum</i>
- xi.** Evolution of sporophyte; apogamy and apospory; alternation of generation; economic importance of bryophytes.

**Unit-IV**

- xii. Pteridophytes:** General characteristics, classification of Pteridophytes; General characters of following groups of Pteridophytes and life cycle of representative types shown against each group.

Psilopsida	<i>Psilotum</i>
Sphenopsida	<i>Equisetum</i>
Lycopsida	<i>Lycopodium</i>
Filicopsida	<i>Dryopteris</i>

- xiii.** Heterospory and origin of seed habit; stellar evolution in pteridophytes

**Laboratory Exercises: L-01**

- i. Study of vegetative and reproductive structures of *Chlorella*, *Vaucheria*, *Ectocarpus*, *Batrachospermum*, *Morchella*, *Phytophthora*, *Morchella*, *Agaricus*, *Alternaria*
- ii. Study of morphology, reproductive structures and anatomy of *Marchantia*, *Anthoceros*, *Polytrichum*, *Equisetum*, *Lycopodium*, *Marsilea* and *Dryopteris*.
- iii. Observation of disease symptoms and study of the pathogen in Wheat Rust, Maize Smut and Apple Scab.
- iv. Study of Bacteria from curd and sewage water using crystal violet stain
- v. Study of crustose, foliose and other types of lichen thalli.

**Botany B: Seed Plant Diversity and Systematics****Unit: I**

- i. **Gymnosperms:** General characters, Sporne's system of classification; diversity and phylogeny of gymnosperms.
- ii. **General characters of** Cycadales, Ginkgoales, Welwitschiales, Gnetales, Ephedrales, Pinales, Araucariales, Cupressales.
- iii. **Morphology, anatomy and reproduction in** *Cycas*, *Pinus* and *Ephedra*.
- iv. **Fossil gymnosperms:** *Caytonia*, *Williamsonia*.

**Unit: II**

- v. **Angiosperm taxonomy:** Brief history; scope of taxonomy; fundamental components of taxonomy;
- vi. **Angiosperm evolution and classification:** Diversity and phylogeny of angiosperm; salient features of classification systems proposed by Bentham and Hooker, Takhtajan, and Angiosperm Phylogeny Group (APG); characters of primitive angiosperms with special reference to *Magnolia* and *Ranunculus*.

### Unit: III

- vii. **Botanical nomenclature:** Brief history and principles of International Code of Botanical Nomenclature (ICBN) ( taxonomic hierarchy; type concept.
- viii. **Plant identification:** Methods of plant identification, types of identification keys; contribution of morphology, anatomy and embryology in plant taxonomy (with suitable examples in all).

### Unit: IV

- ix. **Taxonomic institutions:** Methods of herbaria;, role of botanical gardens
- x. **Diversity of Angiosperms:** Morphology and economic importance families- Brassicaceae, Papilionaceae, Apiaceae; Rosaceae, Asteraceae, Solanaceae, Lamiaceae; Liliaceae, and Poaceae.
- xi. **Life cycles in plants:** Annuals, biennials and perennials.

### Laboratory Exercises :L-01

- i. Taxonomic description of the following families: Ranunculaceae ( *Ranunculus/ Delphinium*); Brassicaceae ( *Brassica /Iberis*); Malvaceae (*Malva/ Althaea*) ; Papilionaceae ( *Lathyrus/ Trifolium*); Rosaceae (*Rosa/ Potentilla*); Asteraceae (*Helianthus/ Taraxacum*); Solanaceae ( *Solanum/ Datura*) ; Apiaceae (*Daucus/ Scandix*)Lamiaceae ( *Nepeta/ Salvia*); Liliaceae (*Hemerocalis/ Tulipa*);; Poaceae (*Avena/ Poa*) and Iridaceae (*Iris/Gladiolus*) Study of anatomy of root , stem and reproductive structures through prepared slides and hand sections of *Cycas Pinus* and *Ephedra* (***students will have to prepare ten permanent slides for submission at the time of practical examination***).

## B. Sc 2<sup>nd</sup> Year

### Paper A: Structure, Development and Reproduction in Flowering Plants

#### Unit: I

- i. **The root system:** Organization of the root apical meristem; differentiation of primary and secondary tissues and their roles; structural modification for storage, support respiration and reproduction; root-microbe interaction with special reference to mycorrhiza.

#### Unit: II

- ii. **The shoot system:** The shoot apical meristem and its histological organization; vascularization of primary shoot in monocotyledons and dicotyledons; cambium and its functions; formation of secondary xylem; general account of wood structure; formation of growth rings, sapwood and heart wood; secondary phloem-structure and function; periderm; anomalous secondary growth in *Dracena*

#### Unit: III

- iii. **Leaf:** Origin, anatomy of monocotyledon (Wheat, Maize) and dicotyledon (*Nymphaea* and Sunflower) leaf.  
iv. **Leaf appendages:** Structure and function of hairs, trichomes, thorns etc.  
v. **Stomata:** types and their characteristics.  
vi. **Vegetative reproduction:** Vegetative propagules and vegetative propagation by different methods; economic aspects.

#### Unit: IV

- vii. **Flower:** Flower as a modified shoot, structure of typical flower; functions and structure of anther and pistil, development of the male and female gametophytes, types of pollination; attractants and rewards for pollinators; pollen-pistil interaction, self incompatibility; double fertilization; formation of seed: development of embryo and endosperm ( in *Capsella* and *Poa* ); fruit development  
viii. **Seed:** Seed appendages and dispersal strategies

### Laboratory Exercises: L-02

- a. Study of a commonly occurring dicotyledonous plant e.g *Solanum nigrum* to understand the body plan and modular type of growth  
b. Growth forms exhibited by flowering plants (herbs, lianas, shrubs, twinners, trees)  
c. L.S. of shoot tip to study the cytohistological zonation and origin of leaf primordia from prepared slides  
d. Microscopic study of wood in T.S / T.L.S/ R.L.S from prepared slides of *Pinus* and *Populus*.  
e. Study of anatomy and secondary growth in monocots (*Dracaena*) and dicots using hand sections and prepared slides.  
f. Study of diversity in leaf shape, size, thickness, surface features and internal structure (Maize and Sunflower leaves)  
g. Study of anatomy of root of monocots and dicots (Maize and Sunflower roots)

- h. Study of different types of flowers in relation to sexuality and adaptation to pollination mechanisms (Maize, *Cannabis* and *Ranunculus*)
- i. Study of the structure of anther, micro-sporogenesis, pollen grains and pollen viability through squash technique (any available material)
- j. Study of the structure of ovule and embryo sac from prepared slides
- k. Study of nuclear and cellular endosperm (Coconut, cucurbits)
- l. Simple experiments to show vegetative propagation (cutting, layering and grafting)
- m. Study of germination of non-dormant and dormant seeds (pea, maize, bean, tomato)

## Botany- B: Cell Biology and Genetics

### Unit –I

- i. **Cell architecture:** Prokaryotic and Eukaryotic cells.
- ii. **The cell envelope:** Plant cell wall-ultrastructure and function; Plasma membrane: Fluid Mosaic Organization (model) and functions;
- iii. **Non-membrane organelle:** Structure and function of Ribosomes
- iv. **Single membrane organelles:** Structure and function of Endoplasmic reticulum and Golgi bodies
- v. **Double membrane organelles:** Mitochondria and Plastids
- vi. **Nucleus:** Ultra structure, nuclear envelope, nucleolus; functions

### Unit-II

- vii. **Chromosome organization:** Nucleosome organization, Morphology of chromosome; chemical composition, characteristics and role of centromere and telomere;
- viii. **Genetic material:** Structure of DNA (Watson & Crick model), DNA replication (Semi-conservative), DNA as genetic material (experimental proof)
- ix. **Cell cycle:** Mitosis and Meiosis – mechanism and significance

### Unit- III

- x. **Mendelism;** Symbols and terminology, Mendel's laws of inheritance, Monohybrid, dihybrid and test crosses (suitable examples),
- xi. Modifications of Mendelian ratios (allelic and non-allelic interactions) – incomplete dominance, Co-dominance, epistasis, complementary genes, duplicate genes and multiple alleles (with suitable examples in all).
- xii. **Linkage and crossing over:** Coupling and repulsion hypothesis, chromosome theory of linkage, mechanism of crossing over.
- xiii. **Chromosome alterations:** Origin and meiotic behavior of deletions, duplications, translocations and inversions; variations in chromosome number, aneuploidy and polyploidy (types, origin and significance).

### Unit: IV

- xiv. **RNA:** Structure, types and properties of RNA (mRNA, tRNA, rRNA), properties of genetic code, mechanism of transcription and translation (prokaryotes).
- xv. Regulation of gene expression in prokaryotes (Lac operon).
- xvi. **Gene mutations:** Concept and types of point mutations, frame shift mutations – concept and significance.

### **Laboratory Exercises:L-02**

- i. To study cell structure from onion leaf peels; demonstration of staining and mounting methods.
- ii. Comparative study of cell structure in onion cells, *Hydrilla* and *Spirogyra*. Study of cyclosis in *Tradescantia* staminal cells.
- iii. Study of plastids to examine pigment distribution in plants (*Lycopersicon* and *Capsicum*).
- iv. Examination of electron micrographs of eukaryotic cells with special reference to organelles.
- v. Study of electron micrographs of viruses, bacteria, cyanobacteria and eukaryotic cells for comparative cellular organization
- vi. Examination of various stages of mitosis and meiosis using available plant material.
- vii. Demonstration of karyotypes from prepared slides and photomicrographs
- viii. Cytological examination of special types of chromosomes: bar bodies, lampbrush and polytene chromosomes from prepared slides.
- ix. Working out the laws of inheritance (3:1; 9:3:3:1 ) and gene interaction (13:3; 9:7) using seed mixtures.

## B. Sc 3<sup>rd</sup> Year

### Paper A: PLANT PHYSIOLOGY AND BIOCHEMISTRY

#### Unit: I

- i. **Plant water relations:** Importance of water to plant life, physical properties of water; diffusion, bulkflow, osmosis; absorption, transport and transpiration; physiology of stomata.
- ii. **Mineral nutrition:** Essential macro- and micro-nutrient elements and their role; ion uptake; mineral deficiency and toxicity symptoms.
- iii. **Transport of organic substances:** evidences and mechanism of phloem transport; source-sink relationship.

#### Unit-II

- iv. **Proteins:** Classification of proteins based on structure and solubility.
- v. **Basics of enzymology:** Discovery and nomenclature; characteristics of enzymes; concept of holoenzyme, apoenzyme, coenzyme and cofactors; mechanism of enzyme action.
- vi. **Nitrogen metabolism:** Biology of nitrogen fixation; ammonium assimilation.
- vii. **Lipids:** Structure, properties and functions of triacylglycerols.

#### Unit: III

- viii. **Photosynthesis:** Photosynthetic pigments; absorption & action spectra, enhancement effect; concept of two photosystems; Z-scheme; photophosphorylation; C<sub>3</sub>, C<sub>4</sub> and CAM pathways; photorespiration.
- ix. **Respiration:** ATP- the biological energy currency; aerobic and anaerobic respiration; Glycolysis, Krebs cycle; electron transport system, oxidative phosphorylation (chemi-osmotic mechanism).

#### Unit: IV

- x. **Growth and development:** Differentiation and morphogenesis (elementary idea); phases of growth, concept of phasic development; kinetics of growth.
- xi. **Seed dormancy:** Physiology of dormancy; seed germination and factors regulating seed germination.
- xii. **Physiology of flowering:** Photoperiodism; vernalization.
- xiii. **Plant movements:** Tropic and nastic movements.
- xiv. **Plant hormones:** History of discovery and physiological effects of auxins, gibberellins, cytokinins, abscissic acid and ethylene.

### Laboratory Exercises: L-03

- a. To study permeability of plasma membrane using different concentrations of organic solvents.
- b. To study effect of temperature on permeability of plasma membrane.



- c. To study the enzyme activity of catalase and peroxidase as influenced by pH and temperature.
- d. Comparison of the rate of respiration of various plants.
- e. Separation of chloroplast pigments by solvent method.
- f. Determining the osmotic potential of vacuolar sap by plasmolytic method.
- g. Determining the water potential of any tuber.
- h. Demonstration of chromatographic separation of chloroplast pigments.

## **Paper B: ECOLOGY, UTILIZATION OF PLANTS AND BIOTECHNOLOGY**

### **Unit: I**

- i. **Plants and environment:** Atmosphere (gaseous composition and layering of atmosphere); water (properties, reservoirs and water cycle); soil (development, soil profile, physico-chemical properties (texture and pH); basic concept of climate change and its impact on plants.
- ii. **Ecological adaptations:** Morphological, anatomical and physiological adaptation of plants to water (hydrophytes and xerophytes); chilling and light.
- iii. **Forest types of India:** Characteristics of various types as per Champion and Seth's Classification.
- iv. **Biogeographical regions of India.** Characteristics of various regions as per Rogers and Panwar's Classification.

### **Unit: II**

- v. **Population ecology:** Primary and secondary characters of population; outline of intra- and interspecific population interactions with special emphasis on intra- and inter-specific competition.
- vi. **Community ecology:** Community characteristics (analytic and synthetic); community development through ecological succession (Hydrosere and Xerosere).
- vii. **Ecosystems:** Structure, abiotic and biotic components, food chains, food webs, ecological pyramids, energy flow, biogeochemical cycles of carbon, nitrogen and sulphur.

### **Unit: III**

- viii. **Archaeobotany and Ethnobotany:** Plant use through ages; ethnobotany and its scope.
- ix. **Food Plants:** Morphology, cultivation and economic importance of Rice, and Potato
- x. **Fibres:** Morphology, cultivation, extraction and economic importance of jute.
- xi. **Vegetable oils:** Fixed and volatile oils; morphology, cultivation, extraction and economic importance of mustard.
- xii. **Wood:** General account of hard and soft woods.
- xiii. **Spices and Condiments:** Source, part used and uses with particular reference to Kashmir.
- xiv. **Medicinal and Aromatic Plants (MAPs):** Morphology and uses of *Podophyllum* and *Lavendula*.
- xv. **Beverages:** Morphology, cultivation, and processing of tea.

**Unit: IV**

- xvi. **Tissue culture:** Basic aspects of plant tissue culture, cellular totipotency, differentiation and morphogenesis, applications of plant tissue culture (conservation, agriculture, industry).
- xvii. **Genetic engineering:** Tools and techniques of recombinant DNA technology; cloning vectors (plasmids); construction of recombinant DNA, applications of genetic engineering.
- xviii. **Polymerase chain reaction-** principle and applications; transgenics--concept and application.

**Laboratory Exercises: L-03**

- a. To determine minimum number of quadrats required for reliable estimate of density in grasslands.
- b. To study frequency, and importance value index of grassland species.
- c. To estimate bulk density and porosity of grassland and forest soils.
- d. To determine moisture content and water holding capacity of grassland and forest soil.
- e. To estimate transparency, pH and temperature of different water bodies.
- f. To study the morphology and food reserves of food plants like rice, wheat, maize, potato through chemical tests.
- g. To demonstrate the distribution of surface (cotton) and bast fibres (hemp).
- h. Study the distribution of oil bodies in some oil containing seeds (mustard, linum, coconut, groundnut, walnut etc)
- i. Examine morphologically some common spices.
- j. Prepare an illustrated inventory of 10 medicinal plants used in traditional systems of medicine.

**Suggested Readings:****B. Sc 1<sup>st</sup> Year****Paper A: Diversity of Microbes and Cryptogams**

1. Singh, V., Pande, P. C. and Jain, D.K.. 2010. Diversity of Microbes and Cryptogams. Rastogi Publications, Meerut, India.
2. Kumar, H.D. 1999. Introductory Phycology. East-west Press Ltd., New Delhi.
3. Vashishta, B.R., Sinha, A.K. and Singh, V.P. 2008. Botany for Degree Students-Algae. S. Chand and Company Pvt. Ltd., New Delhi.
4. Sharma, P.D. 2003. Microbiology. Rastogi Publications, Meerut, India.
5. Alexopoulos, C.J. and Mims, C.W.: Introductory Mycology. 2002. 5<sup>th</sup> edition. John Wiley and Sons, New York.
6. Webster, John. 1996. Introduction to Fungi ... Cambridge University Press, London.

7. Singh, R.S. 1990. Principles of Plant Pathology. Oxford and IBH Publishers, New Delhi
8. Singh, R. S. Plant Diseases. Oxford and IBH Publishers, New Delhi.
9. Mehrotra, R.S and Aneja, K.R. An Introduction to Mycology. A New Age International Press, New Delhi.
10. Shaw, A. J and Goffinet, B. 2000. Bryophyte Biology. Cambridge University Press.
11. Vanderpoorten, A. and Goffinet, B. 2009. Introduction to Bryophytes. Cambridge University Press.
12. Sambamurty, A. V. S. S. 2005. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International Pvt. Limited.
13. Rashid, A. 1996. An Introduction to Pteridophyta: Diversity and Differentiation. Vikas Publishing house, New Delhi.

### **Paper B: Seed Plant Diversity and Systematics**

1. Singh, Gurcharan 2004. Plant Systematics: Theory and Practice. Oxford & IBH Publishing Co. Pvt. Ltd.
2. Simpson, Michael G. 2006. Plant Systematics. Elsevier, California, USA.
3. Judd, S., Walter et al. 2008. Plant Systematics: A Phylogentic Approach. Sinauer Associates, Inc. Sunderland, USA.
4. Singh, V., Pande, P. C. and Jain, D.K. 2010. Diversity and Systematics of Seed Plants. Rastogi Publications, Meerut, India.
5. Vashishta, P.C. Botany For Degree Gymnosperm. S. Chand & Company, New Delhi.
6. Bhatnagar, S.P. 1996. Gymnosperms. New Age International Publishers Ltd.- New Delhi.
7. Sporne, K. R. 1974. The morphology of gymnosperms( 2<sup>nd</sup> Ed) Hutchinson Univ. Lib, London.
8. Sharma, B. D. 1994. Gymnosperms: Morphology, Systematics, Reproductive Biology.
9. Stewart, W. N. 1983. Palaeobotany and the Evolution of Plants. Cambridge University, Press, Cambridge.

## **B. Sc 2<sup>nd</sup> Year**

### **Paper A: Structure, Development and Reproduction in Flowering Plants**

1. Singh, V., Pande, P. C. and Jain, D.K.. 2010. Structure, Development and Reproduction in Angiosperms. Rastogi Publications, Meerut, India.
2. Bhojwani, S.S. and Bhatnagar, S.P. The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd.
3. Maheshwari, P. 1950. An Introduction to the Embryology of Angiosperms. McGrawHill, New York.
4. Pandey, A.K. 1997. Introduction to Embryology of Angiosperms. CBS Publishers and Distributors, New Delhi.
5. Pandey, S.N. and Chadha. 1996. Embryology. Vikas Publishing house, New Delhi.
6. Cutler, D.F., Botha, T. and Stevenson, D.W. 2008. Plant anatomy: An applied approach. Wiley-Blackwell Publishers.
7. Evert, R.F. and Esau, K. 2006. Esau's Plant Anatomy. John Wiley and Sons.
8. Pandey, B.P. (Recent Edition). Plant Anatomy. S. Chand and Company, New Delhi.

### **Botany-B: Cell Biology and Genetics**

1. Gupta, P. K. 2008. Cytology, Genetics and Evolution. Rastogi Publications, Meerut.
2. Gupta, P. K. 2009. Genetics. Rastogi Publications, Meerut.
3. Gupta, P. K. 2007. Cytogenetics. Rastogi Publications, Meerut.
4. Starr, C., Taggart, R., Evers, C. and Starr, L. 2008. Cell Biology and Genetics. Brooks, Cole.
5. Cooper G.M and Hausman R.E. 2007. The Cell A Molecular Approach Sinauer associate, Inc, Suderland (USA).
6. De Robertis and De Robertis. 2005. Cell and Molecular Biology, Lippincott Williams, Philadelphia. [B.I Publications Pvt. Ltd. New Delhi].
7. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.
8. Strickberger 2005. Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.

## **B. Sc 3<sup>rd</sup> Year**

### **Paper A: PLANT PHYSIOLOGY AND BIOCHEMISTRY**

1. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology. 4<sup>th</sup> Edition. Wadsworth Publishing Company, Inc. California, USA.
2. Hopkins, W.G. and Huner, N.P. 2004. Introduction to Plant Physiology. John Wiley & Sons, Inc. USA.
3. Taiz, L. and Zeiger, E. 2010. Plant Physiology. 5<sup>th</sup> Edition. Sinauer Associates, Inc. USA.

### **Paper B: ECOLOGY, UTILIZATION OF PLANTS AND BIOTECHNOLOGY**

1. Chapman, J.L. and Reiss, M.J. 1997. Ecology: principles and Applications. Cambridge University Press, London.
2. Molles, M.C. Jr. 1999. Ecology: Concepts and Applications. WCB/McGraw-Hill Company, London.
3. Mackenzie, A., Ball, A.S. and Virdee, S.R. 1999. Instant Notes in Ecology. Viva Books Private Ltd. New Delhi.
4. Dash, M.C. 1993. Fundamental of Ecology. 1993. Tata McGraw Hill Publishing Company, Ltd.
5. Colinvaux, P. 1993. Ecology. John Wiley, New York.
6. Odum, E.P. and Barrett, G.W. 2004. Fundamentals of Ecology. Brooks, Cole.
7. Stiling, P. 2001. Ecology: Theories and Applications. Printice-Hall Inc.
8. Shekhawat, M.S. and Vikrant. 2011. Plant Biotechnology. MJP Publishers, Chennai.
9. Bhojwani, S.S. and Razdan, M.K. 1983. Plant Tissue Culture: Theory and Practice: Developments in Crop Science. Elsevier, Amsterdam.
10. Smith, R.H. 2000. Plant Tissue Culture: Techniques and Experiments. Academic Press, Tokoyo.
11. Simpson, B. and Ogorzaly, M. 2000. Economic Botany: Plants in our World. McGraw-Hill Science.
12. Maiti, R.K. & Singh, Ved Pal. 2006. An Introduction to Modern Economic Botany. Eastern Book Corporation, India.

13. Wikens, G. E 2004. Economic Botany- Principles and Practices. Kluwer Publishers, Netherlands.
14. Pooja, S. N. 2010. Economic Botany. Discovery Publishing House, New Delhi.
15. Nehra, S. 2007. Economic Botany. Vedam Books.
16. Gonsalves, J. 2007. Economic Botany and Ethnobotany. Vedam Books