

# **SOLAPUR UNIVERSITY, SOLAPUR**

## **NEW SYLLABUS**

### **BOTANY AT B.Sc. PART – III**

**w. e. f . June – 2009**

The present syllabus is in continuation with the previous class B.Sc. Part II. This syllabus has been prepared as per UGC curriculum. There are four papers in theory which will be covered by engaging THREE lectures per paper each week. There are FOUR practicals per week each of five periods, at the end of the year, there will be a practical examination to be conducted on FOUR consecutive days for not less than Five hours per day. Each theory paper will be of 100 marks and each practical will be of 50 marks.

Paper V	:	Biology of Cryptogams, Microbiology and Plant Pathology	80 periods
Paper VI	:	Gymnosperms, Palaeobotany and Systematics of Angiosperms	80 periods
Paper VII	:	Genetics, Plant breeding and Biostatistics	80 periods
Paper VIII	:	Plant Biochemistry, Molecular Biology and Biotechnology	80 periods

**PAPER V**  
**BIOLOGY OF CRYPTOGAMS, MICROBIOLOGY AND**  
**PLANT PATHOLOGY**

**Section – I**

**Biology of Cryptogams**

**(40 periods)**

- 1.0 **Algae :** (10)
- 1.1 Occurrence and distribution of algae
  - 1.2 Thallus organization in algae
  - 1.3 Origin and evolution of sex in algae
  - 1.4 Types of life cycles in algae-Haplontic, Diplontic, Haplodiplontic-Isomorphic and Heteromorphic, *Haplobiontic- Triphasic, Diplobiontic*.
  - 1.5 Study of life cycle – *Chara, Ectocarpus* and *Batrachospermum*  
(Excluding development of sex organs and sporophyte)
- 2.0 **Fungi** (10)
- 2.1 Reproduction in Fungi
  - 2.2 Study of following types with emphasis on classification, structure of mycelium, nutrition, reproduction and economic importance.  
a) *Albugo* b) *Uncinula* c) *Polyporus* (Excluding developmental stages)
  - 2.3 Mushroom Cultivation
- 3.0 **Bryophytes :** (8)
- 3.1 Evolution of gametophyte and sporophyte
  - 3.2 Study of life cycle of *Marchantia* (Excluding developmental stages)
  - 3.3 Alternation of generations in Bryophytes
- 4.0 **Pteridophytes :** (12)
- 4.1 General account of Pteridophytes with reference to
    - a. Structure of Sporophyte.
    - b. Structure of Sori and Sporangia.
    - c. Structure of gametophytes.
    - d. Alternation of generations in pteridophytes.

- 4.2 Comparative account of morphology, anatomy & reproduction in *Psilotum* and *Marsilea* (Excluding developmental stages)

## Section – II

### Microbiology and Plant Pathology (40)

#### 5.0 Microbiology :

- 5.1 Methods in Microbiology – Sterilization methods, Types of Culture media, Pure Culture methods. (8)
- 5.2 Introduction to microbiology, classification & characteristic features – of different groups. (8)
- 5.3 Industrial applications of micro-organisms, organic acids, alcohol, food processing, milk products, antibiotics and biopesticides. (8)

#### 6.0 Plant Pathology: (16)

- 6.1 Classification of plant diseases based on Pathogens, Crops, Symptoms and Transmission of pathogen.
- 6.2 Phytoplasma – Little leaf of Brinjal
- 6.3 Viral – Leaf curl of chillies
- 6.4 Bacterial – Bangadi disease of potato.
- 6.5 Fungal –
- a) Downy mildew of Bajara
  - b) White rust of Crucifer.
  - c) Grain Smut of Jowar
  - d) Anthracnose of Bean

## Paper – VI

### GYMNOSPERMS, PALAEOBOTANY AND SYSTEMATICS OF ANGIOSPERMS

#### Section – I (40)

#### Gymnosperms and Palaeobotany

1. **Gymnosperms :** (16)  
Study of Cycadales – *Zamia* and Gnetales – *Gnetum* with reference to distribution, organography, anatomy and reproductive structures - Sporophytes and gametophytes, fertilization, seed structure and phylogeny.
2. **Palaeobotany :**
  - 2.1 a. Geological time-scale (3)  
b. Carbon dating (2)
  - 2.2 a. Process of fossilization and their types (4)  
b. Concept of form genera and nomenclature (2)
  - 2.3 Study of following Form genera with reference to systematic position, external morphology, anatomy and affinities. (8)
    - a. *Calamites*
    - b. *Cycadeoidea*
    - c. *Lyginopteris*
    - d. *Enigmocarpon*
  - 2.4 Application of Palaeobotany in oil and coal exploration (5)
    - a. Oil and coal as fossil fuels.
    - b. Role of microfossils in exploration.
    - c. Biotic origin of oil and coal.
    - d. Oil excavation.

**Systematics of Angiosperms**

3)

3. **Phylogeny of angiosperms.** (4)  
 3.1 A general account of the origin and evolution of Angiosperms  
 (With special reference to Bennettitalean, Gnetalean)  
 3.2 Primitive and Advanced features of flower.
4. **Systems of Classification.** (2)  
 Engler and Prantl's system
5. **Modern Taxonomy.** (4)  
 Taxonomy in relation to anatomy, embryology, palynology, ecology, cytology (Cytotaxonomy), secondary metabolites in plants (Chemotaxonomy)
6. **Flower**  
 Concept of flower as a modified shoot. (2)  
 Structure of anther – Microsporogenesis (3)  
 Structure of Pistil – Structure of typical ovule, ovule types, megasporogenesis, Female gametophyte (embryo sac), Embryosac types – monosporic, bisporic and tetrasporic. (5)
7. **Pollination and Fertilization** (5)  
 Mechanism of Pollination and agencies.  
 Pollen germination and pollen tube growth  
 7.3 Fertilization  
 7.4 Double fertilization  
 7.5 Endosperm
8. **Seed and Fruit** (3)  
 8.1 Development of embryo in Monocotyledons and Dicotyledons,  
 8.2 Seed and Fruit dispersal.

9. **Angiosperm families** (12)

9.1 Study of following Angiosperm families with respect to systematic position, morphological characters & economic importance.

- |                     |                    |                   |
|---------------------|--------------------|-------------------|
| i) Ranunculaceae    | ii) Rutaceae       | iii) Myrtaceae    |
| iv) Cucurbitaceae   | v) Fabaceae        | vi) Asteraceae    |
| vii) Convolvulaceae | viii) Bignoniaceae | ix) Amaranthaceae |
| x) Polygonaceae     | xi) Liliaceae      | xii) Poaceae      |

**Paper VII**  
**GENETICS, MICROBIAL GENETICS, PLANT BREEDING AND**  
**BIOSTATISTICS**

Section – I (40)

**Genetics**

**1.0 Mendelism (6)**

1.1 Introduction and Basic terminologies in genetics.

1.2 Principles of Inheritance.

a) Law of Dominance

b) Law of Segregation

c) Law of Independent assortment.

1.3 Gene Interactions

a) Complementary gene interactions

b) Supplementary gene interactions.

c) Inhibitory gene Interactions

**2.0 Linkage and Crossing Over (7)**

2.1 Introduction

2.2 Linkage – Definition, coupling and repulsion.

2.3 Types of Linkage – Complete and Incomplete linkage

2.4 Linkage groups

2.5 Crossing over – Definition, Mechanism of crossing over.

2.6 Theories of crossing over – Belling's copy choice theory, Darlington's breakage & reunion theory.

**3.0 Multiple Allelism (3)**

3.1 Introduction and definition

3.2 Eye-colour in Drosophila

3.3 Blood groups in man.

3.4 Self incompatibility in plants

- 4.0 **Sex Chromosomes** (7)
- 4.1 Autosomes and sex chromosomes.
  - 4.2 Mechanism of Sex determination.
  - 4.3 Sex chromosomes in Drosophila.
  - 4.4 Sex chromosomes in man.
  - 4.5 Balance concept of Sex determination in Drosophila – Bridges Experiment.
  - 4.6 Sex – linked inheritance in man -
    - a) Colourblindness
    - b) Haemophilia
    - c) Holandric genes
- 5.0 **Quantitative inheritance** (5)
- 5.1 Polygene Theory
  - 5.2 Population genetics, Hardy Weinberg law.
- 6.0 **Maternal Influence of Inheritance** (3)
- 6.1 Mendelian versus extrachromosomal inheritance.
  - 6.2 Examples of maternal inheritance.
    - a) Mitochondrial inheritance
    - b) Plastid inheritance.
- 7.0 **Alterations in the genetic make-up and its significance** (9)
- 7.1 Introduction
  - 7.2 Changes in chromosome structure
  - 7.3 Changes in chromosome number

**Microbial genetics, Plant breeding and Biostatistics**

8.0 **Microbial Genetics** (8)

- 8.1 Introduction
- 8.2 Bacterial genome
- 8.3 DNA viruses
- 8.4 RNA viruses
- 8.5 Recombination in Bacteria  
Conjugation, Transformation, Transduction

9.0 **Methods of Plant Improvement** (14)

- 9.1 Introduction
- 9.2 Aims and objectives of plant breeding.
- 9.3 Scope of plant breeding
- 9.4 Methods of plant breeding
  - I) Introduction and Acclimatization
  - II) Selection
    - a) Mass Selection
    - b) Pure line Selection
    - c) Clonal Selection
  - III) Hybridization  
In self Pollinated and cross pollinated cross.

9.5 **Breeding in field crops** (6)

- a) Breeding in Cotton
- b) Breeding in Sugarcane

10.0 **Role of Mutations and Polyploidy in plant breeding** (3)

11.0 **Biostatistics** (7)

- 11.1 Collection and presentation of data
- 11.2 Measures of central tendency -  
Mean, Mode and Median
- 11.3 Test of Significance (T-test), Chi - square test ( $X^2$ -test)

12.0 **Application of Computer in Biology Education** (2)

**Paper – VIII**  
**BIOCHEMISTRY, MOLECULAR BIOLOGY AND**  
**BIOTECHNOLOGY**

**Section – I** (40)

**Plant Biochemistry**

**1.0 Carbohydrate Metabolism :** (12)

- 1.1 Introduction and broad classification.
- 1.2 Monosaccharides – Properties and examples – Triose, Tetrose, Pentose and Hexose
- 1.3 Oligo saccharides – Properties and examples – Sucrose, Maltose and Lactose
- 1.4 Polysaccharides – Properties and examples – Starch and Cellulose
- 1.5 Isomers, enantiomers and epimers
- 1.6 Biosynthesis of sucrose and starch
- 1.7 Degradation of sucrose and starch.

**2.0 Lipid Metabolism** (12)

- 2.1 Introduction and significance
- 2.2 Classification
- 2.3 Saturated fatty acids-properties and examples – Stearic and Palmitic acid
- 2.4 Unasaturated fatty acids – properties and examples – Linoleic and Linolenic acid
- 2.5 General out line of fatty acid biosynthesis
- 2.6 Beta Oxidation of fatty acids.
- 2.7 Gluconeogenesis of fatty acids during germination.

**3.0 Protein Metabolism** (16)

- 3.1 Introduction,
- 3.2 General structure, properties and characteristics of essential amino acids
- 3.3 Brief out line of biosynthesis of amino acids – Aspartate, Cysteine, Phenylalaine and Proline
- 3.4 Protein structure and classification

3.5 Brief outline of protein biosynthesis in prokaryotes and eukaryotes

3.6 Post translational modifications

**Section – II** (40)

**Molecular Biology and Biotechnology**

**4.0 DNA replication and recombination** (5)

4.1 Structure and forms of DNA -

4.2 Replication of DNA – Types and Mechanism

4.3 Denaturation and renaturation of DNA.

4.4 Recombination at molecular level.

**5.0 Gene Structure, expression and regulation** (8)

5.1 Gene organization in prokaryotes and eukaryotes

5.2 Operon concept – lac operon

5.3 Gene regulation in prokaryotes and eukaryotes

**6.0 Recombinant DNA Technology** (12)

6.1 Introduction and principles

6.2 Enzymes involved in recombinant DNA technology

6.3 Vectors

6.4 Southern and northern blotting technique.

6.5 DNA fingerprinting

6.6 PCR

6.7 DNA libraries

**7.0 Genetic Engineering** (6)

7.1 Introduction to transgenic plants

7.2 Methods of gene delivery – Physical, Chemical and Biological  
(Agrobacterium mediated genetransfer)

7.3 Marker and reporter genes

7.4 Achievements in Plant Biotechnology

8.0 **Plant Tissue Culture**

(9)

8.1 Micropropagation

8.2 Anther culture

8.3 Protoplast isolation and culture

8.4 Somatic Hybridization

8.5 Cell suspension culture & Production of Secondary metabolites

## **PRACTICAL EXAMINATION**

### **B.Sc. Part – III (BOTANY)**

Each candidate must produce a certificate from Head of the Department stating that He/She has completed the practical course in a satisfactory manner, on the lines laid down from time to time by the Academic Council on the recommendations of the Board Of Studies and that the laboratory journal has been properly maintained. The candidate must have recorded his/her observations directly in his/her laboratory journal and written their report of each exercise performed. Every journal shall be checked and signed periodically by concerned teacher and certified by the Head of Botany Department at the end of the academic year.

Candidate shall present the followings at the time of practical examination.

1. Certified laboratory journals, with tour report and field work report.
2. 15 herbarium specimens mounted on sheets. 10 Preserved specimens, 10 Permanent slides. The candidate shall be orally examined (viva-voce) in their submission. The student will not be allowed to appear for practical examination unless he/she submits the journal, submission report & Excursion report duly certified by Head of Botany Department.

#### **Field Work and Tour Report :**

In addition to the number of practicals prescribed the students are required to undertake field excursions to the places of botanical interest and industrial places under the guidance of teachers. There shall be frequent study tours in local areas. One of the excursions shall be to an area having different botanical characters for not more than 12 days. There shall be one teacher in-charge for a batch of students upto 12 and one additional lady teacher is allowed whenever there are girls and T.A. and D.A. be paid to the teachers, peon and field collector as per university rules.

The record of field work, visit report and report of the excursion have to be written in the journal or separately which will be duly signed by the teacher in-charge and certified by the Head of the Botany Department. Collection of rare flowering and non flowering plants such as Orchids Ceropegia , Gnetum, Isoetes, Ophioglossum,

Equisetum, Osmunda etc. should be avoided during excursion. Avoid massive collection of plants. Collections of common weed plants should be preferred. Certified journal and excursion report will be considered for assessment by the examiners.

There are 50 marks for each practical. Distribution of marks for each practical is as follows.

**Distribution of Marks for Practical I (Based on Paper V)**

Cryptogams (Algae, Fungi, Bryophytes, Pteridophytes each six marks)	(24)
Plant Pathology .....	4
Culture technique .....	4
Fermentation Technique .....	4
Micrometry .....	4
Submission .....	5
Journal .....	5
<b>Total marks</b>	<b>50</b>

**Distribution of Marks for Practical II (Based on Paper VI)**

Gymnosperms .....	8
Palaeobotany .....	4
Families .....	10
Genus and Species .....	5
Morphology .....	4
Embryology .....	4
Tour Report .....	5
Submission .....	5
Journal .....	5
<b>Total marks</b>	<b>50</b>

**Distribution of Marks for Practical III (Based on Paper VII)**

Genetic examples .....	6
Karyotype / Abnormalities / Variations in chromosome number .....	10
Identification of mutants / pollination mechanism / sex chromosome ...	6
Breeding technique / crop varieties identification .....	8

Meiosis technique / Male sterility / Self incompatibility .....	5
Biostatistics .....	5
Submission .....	5
Journal .....	5
<b>Total marks</b>	<b>50</b>

**Distribution of Marks for Practical IV (Based on Paper VIII)**

Biochemistry .....	13
Molecular Biology .....	11
Biotechnology .....	6
Microtomy .....	10
Submission .....	5
Journal .....	5
<b>Total marks</b>	<b>50</b>

**B.Sc. III Botany**  
**Practical – I**  
**(Based on Paper V)**

1. Identification of following algae

a) Nostoc    b) Volvox    c) Padina    d) Caulerpa    e) Diatoms

2. Life cycle of Chara.

3. Life cycle of Ectocarpus

4. Life cycle of Batrachospermum.

5. Identification of following Fungi.

a) Phyllachora    b) Alternaria    c) Clavaria

d) Melanospora    e) Rhizopus

6. Life cycle of Albugo

7. Life cycle of Uncinula

8. Life cycle of Polyporus

9. Cultivation of mushrooms

10. Identification of following Bryophytes.

a) Plagiochasma    b) Anthoceros    c) Cyathodium

d) Notothyllus    e) Fossombronia    f) Asterella

11, 12. Life cycle of Marchantia

13. Identification of following Pteridophytes (Any four)

a) Isoetes    b) Adiantum    c) Lycopodium    d) Osmunda

e) Asplenium    f) Azolla    g) Blechnum    h) Ophioglossum

14. Life cycle of Psilotum

15. Life cycle of Marsilea

16, 17. Preparation of PDA and sterilization.

18. Isolation and inoculation

19. Micrometry

20, 21, 22, 23. Plant diseases as per theory

24. Study of fermentation by yeast. by inverted tube method.

25. Microbial staining.

**B.Sc. III Botany**  
**Practical – II**  
**(Based on Paper VI)**

1. Study of Anatomical structure in rachis of Cycas and Zamia (section)
2. Study of Anatomical structure in wood of Pinus (Section and Maceration)
3. Study of Structure of male and female cones of Cycas, and Gnetum.
4. Study of Pollen grain structure of Cycas, and Gnetum (shape, size, exine, germ pore number and number of constituent cells)
5. Study of fossil types – Impression, Compression and Petrification.
6. Study of fossils – Calamites, Cycadeoidea, Lyginopteris, Enigmocarpon.
7. Study of V.S. of typical ovule and types of ovules.
8. Study of Pollen grain germination (hanging drop and sitting drop techniques in Impatiens and Catharanthus roseus or any suitable material)
9. Diversity in the structure of stigma, style, stigmatic papillae and transmitting tissue of style in suitable material (Clitoria, Hibiscus, Maize, Ocimum & Citrus)
10. Study of embryo with suspensor in Cucumis & Grevillea (Microdissection)
11. Study of self incompatibility in Hamelia patens and Pentas.
12. Study of seed dispersal with suitable materials.
13. Study of fruit dispersal with suitable materials.
14. Study of Herbarium technique
- 15 to 24 Study of following plant families.

i) Annonacea

ii) Capparidaceae

iii) Rutaceae

iv) Meliaceae

v) Myrtaceae

vi) Cucurbitaceae

vii) Fabaceae

viii) Rubiaceae

ix) Bignoniaceae

x) Lamiaceae

xi) Amaranthaceae

xii) Polygonaceae

xiii) Liliaceae

xiv) Poaceae

**B.Sc. III Botany**  
**Practical – III**  
**(Based on Paper VII)**

1. Study of Mendelian traits in garden pea.
2. Examples of linkage and crossing over.
3. Examples on polygene inheritance.
- 4, 5. Determination of 'chromosome count' in Allium / Iphigenia root tips.
- 6, 7. Study of Meiosis in PMC of Allium or any suitable material.
8. Preparation of karyotypes – idiograms by using photographs.
9. Determination of interspecific variations in chromosome number in Allium.
10. Study of giant chromosome in Drosophila.
11. Detection of meiotic anomalies in chromosomes in Rhoeo.
- 12, 13. Identification of mutant phenotypes – Body shape / nature of wings / eye colour / nature of eye – Normal and bar in Drosophila
14. Study of correlation of floral structure in insect pollinated plants (Any two)  
Salvia, Sesamum, Pea, Plectranthus, Ceropegia, Helianthus, Calotropis, Tridax
15. Study of correlation of floral structure with pollination system in castor and maize.
16. Field exploration for detection of male sterile line in Jowar / Maize
17. Determination of pollen fertility by using staining technique.
18. Breeding technique in Brassicaceae.
19. Breeding technique in Fabaceae.
20. Breeding technique in Malvaceae.
21. Breeding technique in Poaceae.
22. Camera Lucida drawings (Minimum two)
23. Measure of central tendency of given data.
- 24, 25. Analysis of the given data using computer / study of frequency distribution and its graphic presentation.

**B.Sc. III Botany**  
**Practical – IV**  
**(Based on Paper VIII)**

1. Qualitative tests for sugar in plant material –
2. Qualitative tests for starch and cellulose in plant material.
3. Qualitative tests for proteins in plant material.
4. Qualitative tests for lipid in plant material.
5. Determination of isoelectric point of protein in plant material.
6. Determination of fatty acid value of oil sample.
7. Separation of amino acids in plant extract by ascending paper chromatography / TLC.
8. Estimation of proteins in plant sample by Biuret method.
9. Colorimetric estimation of DNA using diphenyl amine.
10. Isolation of plant genomic DNA and its spooling
- 11, 12. Isolation of total RNA from plant tissue and its colorimetric estimation.
- 13, 14. Preparation of tissue culture medium (M.S.) and its sterilization.
- 15, 16, 17. Demonstration of techniques of in vitro culture of various explants.
- 18 to 25. Micro-technique – preparation of permanent stained slides using microtome.

## **List of Books Recommended for B.Sc. III Botany**

1. Blod, I.C., Aloxpoulos, G.J. and Delevoryas, T. 1980. Morphology plant and Fungi (4<sup>th</sup> Edition) Harper and Foul Co., New York.
2. Clifton, A. 1958 Introduction to the Bacteria. McGraw Hill Co., New York.
3. Dube, I.C. 1990. An Introduction to Fungi Vikas Publishing House Pvt. Ltd., Delhi.
4. Gifford, E.M. and Foster, A.S. 1989. Morphology and Evolution of Vascular Plants W.H. Freeman & Co., New York.
5. Gilbert, M.S. 1985. Cryptogamic Botany Vol. I & II (2<sup>nd</sup> Edition), Tata Mcgraw Hill Publishing Co., Ltd., New Delhi.
6. Kumar, H.D. 1988, Introductory Phycology. Affiliated East-West Press Ltd., New York.
7. Mandahar, C.L. 1998 Introduction to plant Viruses Chand & Ltd., Delhi.
8. Puri, P. 1985. Bryophytes. A<sup>+</sup> maram & Sons, Delhi.
9. Rangswamy, G. and Mahadevan A. 1999. Diseases of Crop Plants in India, Prentice Hall India Pvt. Ltd., New Delhi.
10. Sporne, K.R. 1991. The Moropology of Gymmosperms. B. I Publications Pvt., Bombay, Calcutta, Delhi.
11. Wilson, N.S. and Rothwell, G.W. 1983 Palaeobotany and the Evolution of Plants (2<sup>nd</sup> Edition). Cambridge University Press U.K.
12. Cronquist, A.. 1968. The evolution and classification of flowering plants. Thomas Nelson (Printers) Ltd., London & Edinburgh.
13. Delevoryas, Th. 1965 Plant Deversification. Modern Biology Series. Half Rinehart & Winston, New York.
14. Foster, A.S. and Gifford, A.E.M. jr. 1967. Comparative Morphology o Vascular Plants Vakils, Peffer & Simons Pvt. Ltd.
15. Sporne, K.R. 1977. The Morphology of Angiosperms B.I. Publication, Bombay.
16. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms 4<sup>th</sup> revised and enlarged edition, Vikas Publishing House, Delhi.
17. Johri, B.M. 1984. Embryology of Angiosperms, Springer – Verlag Berlin.

18. Raghvan, V. 1997. *Molecular Embryology of Flowering Plants*. Cambridge University Press, New York.
19. Agrios. G.N. 1997. *Plant Pathology* Academic Press, London.
20. Albajes, R., Gullino, M.L. Van Lenteren, J.C. and Elad, Y. 2000. *Integrated Pest and Disease Management in Greenhouse Crops*, Kluwer Academic Publishers.
21. Bridge P.et.al 1998. *Molecular Variability of Fungal Pathogens*. CAB International UK.
22. Bridge P.et. al. 1999. *Application of PCR in Mycology* CAB International, UK.
23. Bridge. P. Moore, D.R. and Scott, P.R. 1998. *Informational Technology, Plant Pathology and Biodiversity* CAB International, UK.
24. Persley, G.J. 1996. *Biotechnology and Integrated Pest Management* CAB International, UK.
25. Skerritt, J.H. and Apples, R. 1995. *New Diagnostics in Crop Sciences*. CAB International, UK.
26. Davis, P.H. and Haywood, V.H. 1963. *Principles of Angiosperm Taxonomy*, Oliver and Royd, London.
27. Heywood, V.H and Moore D.M. 1984. *Current Concepts in Plant Taxonomy*, Academic Press, London.
28. Jones, S.B. Jr. and Luchsinger, A.E. 1986. *Plant Systematics* (2<sup>nd</sup> edition) McGraw-Hill Book Co., New York.
29. Lawrance. G.H.M. 1951. *Taxonomy of Vascular Plants*. MacMillan, New York.
30. Naik, V.N. 1984. *Taxonomy of Angiosperms*. Tata McGraw Hill, New York.
31. Radford. A.E. 1986. *Fundamentals of Plant Systematics* Harper and Row,
32. New York.
33. Singh. G. 1999. *Plant Systematics : Theory and practice* Oxford & IBH Pvt. Ltd., New Delhi.
34. Jeffrey, C. 1982. *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge London.
35. Stace. C.A. 1989. *Plant Tasonomy and Biosystematics*. 2<sup>nd</sup> ed. Edward Arnold, London.

36. Woodland. D.E. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey.
37. Nordenstam. B., El-Gazaly, G. and Kassas. M. 2000. Plant Systematics for 21<sup>st</sup> Century Portland Press Ltd., London.
38. Ambasht. R.S. 1988. A Text Book of Plant Ecology Students Friends Co. Varanasi.
39. Cunningham. W.P. and Saifo S.W. 1997. Environmental Science : A Global Concern WCB, McGraw Hill.
40. Buchanan. B.B. Grussem. W. and Jones. R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
41. Collins. H.A. and Edwards D.II. Lefebvre. D.D. and Layzell. D.B. (eds) 1997. Plant Metabolism (2<sup>nd</sup> Edition) Longman, Essex, England.
42. Lea. P.J. and Leegood, R.C. 1999. Plant Biochemistry and Molecular Biology (2<sup>nd</sup> Edition). John Wiley and Sons, Chichester, England.
43. Lodish. H. Berk, A. Zipursky. S.L. Matsudaira. P. Baltimore. D. and Darnel. J. 2000. Molecular Cell Biology (4<sup>th</sup> Edition) W.H. Freeman and Co. New York USA.
44. Old. R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation. Blackwell Scientific Publications. Oxford UK.
45. Raghavan. V. 1986. Embryogenesis in Angiosperms : A Development and Experimental Study. Cambridge University Press New York, USA.
46. Vasil, L.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture Kluwer Academic Publishers, The Netherlands.
47. Hackett. P.B. Fuchs. J.A. and Messing J.W. 1988. An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin / Cummings Publishing Co., Inc., Menlo Park California.
48. Hall R.D. (Ed.) 1999. Plant Cell Culture Protocols Humana Press Inc. New Jersey, USA.
49. Ninfa A.J. and Ballou D.P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press. Inc., Maryland USA.
50. Scott. R.P.W. 1995. Techniques and Practices of Chromatography Marcel Dekker, Inc. New York.

51. Eklund C. and Lankford. C.W.E. 1967. Laboratory Manual for General Microbiology. Prentice-Hall Inc. Engle-wood Cliffs. N.J.
52. Cunasekaran. P. 1995. Laboratory Manual in Microbiology. New Age International Pvt. Ltd.
53. Pawsey. R.K. 1974. Techniques with Bacteria – A Gidebook for Teachers. Hutchinson Educational.
54. Pelezor. M.J. and Chan. E.C.S. 1972. : Laboratory Exercise in Microbiology, McGraw Hill Book. Co.
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