

UNIVERSITY OF KERALA
THIRUVANANTHAPURAM



COMPLEMENTARY COURSE

BOTANY

FOR

FIRST DEGREE PROGRAMME IN ZOOLOGY/ HOME SCIENCE

UNDER

CHOICE BASED CREDIT- SEMESTER SYSTEM
(w.e.f. 2014 admission onwards)

SEMESTER-I

**MICROTECHNIQUE, ANGIOSPERM ANATOMY AND
REPRODUCTIVE BOTANY**

SEMESTER-II

**PHYCOLOGY, MYCOLOGY, LICHENOLOGY, BRYOLOGY,
PTERIDOLOGY, GYMNOSPERMS AND PLANT PATHOLOGY**

SEMESTER-III

**SYSTEMATIC BOTANY, ECONOMIC BOTANY, ETHNO
BOTANY AND PLANT BREEDING**

SEMESTER-IV

**PLANT PHYSIOLOGY, PLANT ECOLOGY, HORTICULTURE
AND PLANT BIOTECHNOLOGY**

Course code	Course title	Semester I		Semester II		Semester III		Semester IV		Total		
		Contact hours	Credit	Contact hours	Credit	Contact hours	Credit	Contact hours	Credit	Contact hours	Credit	
BO1131	Microtechnique, Angiosperm Anatomy and Reproductive Botany	2	2								4	2
BO1231	Phycology, Mycology, Lichenology, Bryology, Pteridology, Gymnosperms and Plant Pathology			2	2						4	2
BO1331	Systematic botany, Economic botany, Ethno botany and Plant Breeding					3	3				5	3
BO1431	Plant Physiology, Ecology, Plant Biotechnology and Horticulture							3	3		5	3
BO1432	Practical BO1131,BO1231 ,BO1331 &BO1431	2		2		2		2			8	4
												14

SEMESTER-I

MICROTECHNIQUE, ANGIOSPERM ANATOMY AND REPRODUCTIVE BOTANY

Course code: BO1131

Number of credits: 2

Number of contact hours: 72 hrs (Lecture 36 & Practical 36)

Distribution of Hours	Theory	Practical
Microtechnique	06 hrs	00 hrs
Angiosperm anatomy	20 hrs	32 hrs
Reproductive Botany	10 hrs	04 hrs
Total	36 hrs	36 hrs

MODULE-I

Microtechnique

6 hrs

1. Killing and fixation agents – Carnoy's formula, F .A. A
2. Stains and staining techniques - double staining. General account; Stains: saffranin, hematoxylin, acetocarmine.

MODULE-II

Angiosperm anatomy

10 hrs

1. Objective and scopes of plant anatomy
2. Tissues – Meristems, Definition and Classification based on origin, position, growth patterns, functions.
3. Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica -Corpus theory. Organization of root apex in dicots & monocots.
4. Permanent tissues – Definition, classification - simple, complex and secretory.

5. Tissue systems – Epidermal tissue systems, Ground tissue systems & vascular tissue systems. Different types of vascular arrangements.

MODULE-III

10 hrs

6. Primary structure – Root, stem and leaf [Dicot & Monocot]. Secondary growth (stelar and extra stelar) Root and stem- cambium (structure and function) annular rings, heart wood and sap wood, tyloses, ring porous wood and diffuse porous wood, periderm formation, phellum, phellogen and phelloderm ; lenticels

7. Anomalous secondary growth –*Boerhaavia*

Practical

32 hrs

1. Familiarize killing and fixing agents, stains

2. Simple permanent tissue – Parenchyma, Chlorenchyma , Aerenchyma , Collenchyma and Sclerenchyma

3. Primary structure – Dicot stem: *Hydrocotyle*

4. Monocot stem: Grass

5. Dicot root: Pea, *Limnanthemum*

6. Monocot root: *Colocasia*.

7. Secondary structure - Stem [Normal type]- *Vernonia* or any normal type

8. Secondary structure - Root [Normal type]- *Tinospora*, *Ficus*, *Carica papaya*, or any normal type

9. Anomalous secondary thickening –*Boerhaavia*

MODULE-IV

Reproductive Botany

10 hrs

1. Micro sporogenesis - structure and functions of wall layers.

2. Development of male gametophyte - Dehiscence of anther.

3. Megasporogenesis - Development of female gametophyte - Embryo sac – Development and types - Monosporic – *Polygonum* type

4. Pollination - Fertilization - Double fertilization. Structure of Embryo- Dicot [*Capsella*]

Practical**4 hrs**

Students should be familiar with the structure of anther and embryo.

(Permanent slides can be used)

REFERENCES

1. Prasad and Prasad (1972) Out lines of Botanical Micro technique, Emkay publishers, New Delhi Coutler E. G. (1969) Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
2. Esau K. (1965) - Plant Anatomy – Wiley Eastern, New York.
3. Fahn A. (1985) - Plant Anatomy – Pergamon Press, Oxford.
4. Pandey, B .P. (1997) - Plant Anatomy - S.Chand and co. New Delhi Biology – McGraw Hill Co , New York.
5. Vashista .P. C (1984) - Plant Anatomy – Pradeep Publications – Jalandhar
6. P. Maheswari - Embryology of Angiosperms - Vikas Pub:

SEMESTER-II

PHYCOLOGY, MYCOLOGY, LICHENOLOGY, BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PLANT PATHOLOGY

Course code : BO1231

Number of credits : 2

Number of contact hours : 36 hrs (Lecture); 36 hrs (Practical)

Distribution of Hours	Theory	Practical
Phycology	09 hrs	08 hrs
Mycology	09 hrs	08 hrs
Bryology	06 hrs	06 hrs
Pteridology	06 hrs	06 hrs
Gymnosperms	03 hrs	04 hrs
Plant Pathology	03 hrs	04 hrs
Total	36 hrs	36 hrs

MODULE-I

Phycology

9hrs

1. Salient features of the following major groups with reference to the structure, reproduction and life cycle of the types given below (Excluding the developmental details) –

- a) Cyanophyceae - *Nostoc*
- b) Chlorophyceae - *Chlorella*, *Oedogonium* and *Chara*
- c) Phaeophyceae - *Sargassum*
- d) Rhodophyceae – *Polysiphonia*

Practical

8 hrs

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labeled sketches of the specimens observed

MODULE-II

Mycology

9hrs

1. Characteristic features of the following major groups with reference to the structure, reproduction and life cycle of the types given below (Excluding the developmental details) –

- a. Zygomycotina - *Rhizopus*
- b. Ascomycotina
 - i. Plectomycetes - *Penicillium*
 - ii. Discomycetes - *Peziza*
- c. Basidiomycotina
 - i. Teliomycetes – *Puccinia*

2. Economic importance of Fungi

Lichenology

General account and economic importance; structure, reproduction and life cycle of *Usnea*

Practicals

8 hrs

A detailed study of structure and reproductive structures of types given in the syllabus and submission of record.

Rhizopus, *Penicillium*, *Peziza*, *Puccinia*, and *Usnea*.

MODULE-IV

6hrs

Bryology

1. Introduction and Classification

2. Study of the habit, thallus organization, vegetative and sexual reproduction and alternation of generation of the following types (Developmental details are not required).

Riccia, *Funaria*

3. Economic Importance of Bryophytes.

Practical

6 hrs

Riccia – Habit - Internal structure of thallus – V. S. of thallus through archegonia, antheridia and sporophyte

Funaria – Habit, V. S. of archegonial cluster, V. S. of antheridial cluster, Sporophyte V.S.

Pteridology

6 hrs

1. Introduction: General characters morphological and phylogenetic classification.

2. Study of the habitat, habit, internal structure, reproduction and life cycle of the following types (Developmental details not required). *Selaginella* and *Pteris*

Practical**6 hrs**

Selaginella : Habit , stem and rhizophore T. S , V .S. of strobilus, Megasporephyll and microsporephyll.

Pteris - Habit, Rhizome and petiole T. S., sporophyll T.S

MODULE-V**Gymnosperms****3 hrs**

1. Introduction and classification of gymnosperms.
2. Study of the Habit, Anatomy, Reproduction and life cycle of - *Pinus* (Developmental details are not required)

Practical**4 hrs**

Pinus - Branch of indefinite growth, spur shoot, T. S of old stem and needle, male and female cone, V .S. of male and female cone.

Plant Pathology**3 hrs**

1. A brief account on the following plant diseases with reference to the symptoms, causative organism, spread of the disease and effective control measures.

- a) Brown spot disease of Paddy
- b) Powdery mildew of Rubber
- c) Tapioca Mosaic Virus
- d) Quick wilt of Pepper

2. Method of preparation and mode of action of the following fungicides- Bordeaux mixture, Tobacco decoction.

Practical**4 hrs**

Students are expected to observe the symptoms and causal organisms of all plant diseases mentioned above.

REFERENCES

1. Fritsch F. B (1945) Structure and Reproduction of Algae Vol.I & II. Cambridge University Press.
2. Smith G.M (1955) Cryptogamic Botany Vol.I, McGraw Hill Vasishta B.R (1990) Botany for Degree Students, Algae, S.Chand & Co.
3. Singh V., Pandey P.C and Jain D.K (1998) A Text book of Botany for Undergraduate Students, Rastogi Publications.
4. Kanika Sharma (2009) Manual of Microbiology, Ane Books Pvt. Ltd.
5. Mamatha Rao (2009) Microbes and Non flowering plants, Impact and applications; Ane Books Pvt. Ltd.

6. Alexopoulos C.J & MIMS C.V (1988). Introductory Mycology, John Wiley & Sons.
7. Jim Deacon (2007) Fungal Biology, 4th edition, Blackwell Publishing, Ane Books Pvt. Ltd.
8. Smith G.M (1955) Ciyptoganiic Botany, Vol.I McGraw Hill.
9. Vashishta B.R. (1990) Botany for Degree Students, Fungi, S.Chand & Co.
10. Shigh V, Pandey PC and Jam D.K (1998) A Text Book of Botany for Under Graduate Students, Rastogi Publications
11. Webster J (1970) Introduction to Fungi, Cambridge University Press.
12. Parihar N .S.–An introduction to Bryophyta - Central Book Depot. Alahabad
13. Vasishta B. R. - Bryophyta - S. Chand and Co. New Delhi
14. Gupta V .K. and Varshneya U. D (1967) – An Introduction to Gymnosperms –Kedarnath, Ramnath – Meerut.
15. Smith G.M. (1955) - Cryptogamic Botany – Vol.II – Mc Graw Hill Co. New Delhi
16. Sporne K. R. (1966) - Morphology of Pteridophytes - Hutchin University Library London
17. Vashista B. R. (1993) - Pteridophyta – S.Chand and co. New Delhi
18. Andrews H.N. (1967) - Studies on Palaeobotany – C .J. Felix.
19. Arnold C. A (1947) - Introduction to Palaeobotany - McGraw Hill Co. New Delhi.
20. Bower F.O. (1935) - Primitive Land Plants - Cambridge, London.

SEMESTER-III

SYSTEMATIC BOTANY, ECONOMIC BOTANY, ETHNO BOTANY, PLANT BREEDING

Course code: BO1331

Number of credits: 3

Number of contact hours: 90 hrs (Lecture 54& Practical 36)

Distribution of Hours	Theory	Practical
Systematic Botany	33hrs	32 hrs
Economic botany	08hrs	04 hrs
Ethnobotany	02hrs	00 hrs
Plant Breeding	11hrs	00 hrs
Total	54 hrs	36 hrs

MODULE- I

Systematic Botany **11 hrs**

1. Floral morphology: Parts of a flower, types of inflorescence (Cymose, Racemose, Special type- Cyathium-Brief account only) aestivation and placentation, Floral diagram and Floral formula.

Systematic Botany

2. Definition, scope and significance of Taxonomy.

3. Systems of classification:

a. Artificial

b. Natural - Bentham and Hooker (detailed account)

c. Phylogenetic

4. Basic rules of Binomial Nomenclature. Definition and importance of Herbarium.

MODULE-II

22 hrs

A study of the following families with emphasis on the morphological peculiarities and economic importance of its members. (Based on Bentham and Hooker's System)

- 1) Annonaceae
- 2) Malvaceae
- 3) Rutaceae
- 4) Leguminosae
- 5) Rubiaceae
- 6) Asteraceae
- 7) Apocynaceae
- 8) Solanaceae
- 9) Verbenaceae
- 10) Euphorbiaceae
- 11) Liliaceae
- 12) Poaceae

Practical / field work

32 hrs

1. Students must be able to identify the angiosperm members included in the syllabus. Draw labeled diagram of the habit, floral parts, L.S of flower, T.S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms.
2. Students must submit the practical records at the time of practical examination.

MODULE-III

Economic botany

8 hrs

Study of the Botanical name, Family, Morphology of useful parts, and utility of the following;

- Cereals and Millets – Paddy and Ragi
- Legumes - Ground nut, Black gram.
- Sugar yielding plants - Sugarcane.
- Spices & condiments - Cumin, Clove, Cardamom and Pepper
- Fibre - Cotton
- Dyes - Henna
- Resins - Asafoetida.
- Tuber crops - Tapioca, Colocasia.
- Tropical Fruits - Banana, Jack Fruit.

- Oil yielding - Sesame oil, Coconut.
- Medicinal plants - *Ocimum* , *Adhatoda*, *Sida*, Turmeric.

Practical

4 hrs

Identify the economic products obtained from the plants mentioned under Economic Botany.

MODULE-1V

Ethnobotany

2 hrs

1. Study of common plants used by tribes-Neem, *Trichopus zeylanicus*

MODULE-V

Plant Breeding

11 hrs

1. Introduction, objectives in plant breeding.
2. Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization - Achievements.
3. Selection - mass selection, pure line selection and clonal selection.
4. Hybridization: Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties.
5. Heterosis and its exploitation in plant breeding.
6. Polyploidy breeding.
7. Breeding for disease resistance.
8. Mutation breeding

REFERENCES

1. Sivarajan, V.V. Introduction to the principle of plant taxonomy, Oxford and IBH Publishing Company
2. Pandey SN and Misra SP, 2008 Taxonomy of Angiosperms; Ane Books Pvt.Ltd.
3. Davis, P.H. and Haywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Royd, London.
4. Heywood, V.H. and Moore D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
5. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-Hill Book Co., New York
6. Lawrence. G.H.M. 1951. Taxonomy of Vascular Plants. Macmillan, New York.

7. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New York.
8. Radford. A.E. 1986. Fundamentals of Plant Systematics Harper and Row, New York.
9. Singh. G.1999.Plant Systematics:Theory aail practice Oxford & IBH Pvt, Ltd. New Delhi.
- 10.Jefftey, C. 1982. An Introduction to Plant Taxonomy.Cambridge University Press, Cambridge London.
- 11.Stace. C.A. 1989. Plant Taxonomy and Biosystematics. 2nd ed. Edward Arnold, London.
- 12.Woodland. D.E. 1991. Contemporary Plant Systematics. Prentice Hall,NewJersay.
- 13.Nordenstam. B., El-Gazaly, G. and Kassas. M. 2000. Plant Systematics for 21st Century Portland Press Ltd., London.
- 14.Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.
- 15.Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York, Ane Books Pvt. Ltd.
- 16.S.K. Jain. Glimpses of Ethnobotany. Oxford and IBH Publishing Company,New Delhi.
- 17.17. S.K. Jain, 1987. A Manual of Ethno botany. Scientific Publishers, Jodhpur
18. Rajiv K Sinha. Ethnobotany
- 19.19.Allard RW (1999). Principles of Plant Breeding (2nd Edition), John Wiley and Sons.
- 20.Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA

SEMESTER-IV

PLANT PHYSIOLOGY, PLANT ECOLOGY, HORTICULTURE AND PLANT BIOTECHNOLOGY

Course code: BO1431

Number of credits: 3

Number of contact hours: 54 hrs (Lecture); 36 hrs (Practical)

Distribution of Hours	Theory	Practical
Plant Physiology	30hrs	14hrs
Plant Ecology	08hrs	12hrs
Horticulture	06hrs	02hrs
Plant Biotechnology	10hrs	08hrs
Total	54 hrs	36 hrs

MODULE-I

Plant Physiology

10 hrs

1. General introduction: physiological processes, their significance and applications.
2. Water relations of plants: Importance of water to plant life.
 - a. Absorption of water- organs of absorption, root and root hair. Physical aspects of absorption- imbibition, diffusion and osmosis. Plant cell as an osmotic system; water potential and osmotic potential. Plasmolysis and its significance, practical applications. Mechanism of water absorption – active and passive absorption, root pressure. Pathway of water across root cells.
 - b. Ascent of sap- vital and physical theories.
 - c. Loss of water from plants: transpiration - cuticular, lenticular and stomatal mechanism - theories – starch sugar hypothesis, potassium - ion theory. Significance of transpiration - guttation, anti - transpirants, factors affecting transpiration.

3. Mineral nutrition: macro and micro elements, role of essential elements and their deficiency symptoms. Mechanism of mineral absorption (a) passive absorption-exchange and Donnan equilibrium (b) active absorption- carrier concept.

MODULE-II

10 hrs

4. Photosynthesis: Introduction, significance and general equation. Photosynthetic apparatus, structure and function of chloroplast, quantasomes - solar spectrum and its importance - Fluorescence and Two pigment systems- raw material for photosynthesis- Mechanism of photosynthesis- Light reaction - cyclic and non cyclic photophosphorylation. Hill reaction - Dark reaction: Calvin cycle. Comparative study of C₃, C₄, and CAM plants. Photorespiration

5. Factors affecting photosynthesis - Law of limiting factor.

MODULE-III

10 hrs

6. Respiration: Introduction, definition and significance and general equation. Respiratory substances, types of respiration- aerobic and anaerobic. Aerobic respiration - glycolysis, Krebs's cycle, terminal oxidation. Anaerobic respiration – fermentation: alcoholic and lactic acid fermentation. Energy relation of respiration - R .Q and its significance – Factors affecting respiration.

7. Translocation of solutes: Path way of movement, phloem transport, mechanism of transport - Munch hypothesis, protoplasmic streaming theory - activated diffusion hypothesis, electro osmotic theory.

8. Growth: Phases of growth - vegetative and reproductive growth - growth curve – plant growth regulators - Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid – synthetic plant hormones - practical applications. Senescence and abscission. Photoperiodism.

Practical

14 hrs

1. Water potential of onion peel / *Rhoeo* peel by plasmolytic method
2. Papaya petiole osmoscope.
3. Determination of water absorption and transpiration ratio.
4. Measurement of rate of transpiration using Ganong's potometer or Farmer's potometer.
5. Evolution of oxygen during photosynthesis.
6. Evolution of CO₂ during respiration.
7. Ganong's respirometer and measurement of R .Q.

8. Simple respiroscope.
9. Alcoholic fermentation using Kuhne's fermentation vessel.
10. Geotropism using clinostat.
11. Measurement of growth using Arc auxanometer.

MODULE-IV

Plant Ecology

8 hrs

1. Definition-Scope and relevance to society and human environment. Need for public awareness
2. Ecosystems-Concept of an ecosystem- structure and function of an ecosystem-
3. Biotic and abiotic components- Energy flow in an ecosystem.
4. Ecological succession-Definition & types.
5. Food chains -Food web & ecological Pyramids.
6. Introduction- types, characteristic features, structure and functions of the following ecosystems.

A 1. Forest ecosystem 2. Grassland ecosystem 3. Desert ecosystem 4 .Aquatic ecosystems- Ponds, Estuaries.

B Morphological, anatomical & physiological adaptations of –
Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites.

Practical

12 hrs

1. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, Halophytes, Epiphytes and Parasites.
2. Observation and study of different ecosystems mentioned in the syllabus.

MODULE-V

Horticulture

6 hrs

1. Introduction to Horticulture
2. Garden tools and implements - Lawn mower, hand trowel, nursery spade, spade fork, garden hoe, weeder, tillers
3. Methods of vegetative propagation: Cutting, grafting, layering, special methods of propagation, propagation by seeds.
4. Media for propagation of plants — soil, sand, peat, sphagnum moss, vermiculture, soil mixture, nursery beds
3. Manures – organic and inorganic

Practical**2 hrs**

Methods of vegetative propagation: Cutting, grafting, layering, special methods of propagation - propagation by seeds.

Biotechnology**10 hrs**

1. Introduction – History – major achievements – Biotechnology in India
2. Plant Tissue culture - Culture media; composition, preparation and sterilization – Totipotency: definition and importance - Dedifferentiation and redifferentiation – Callus and suspension culture, meristem culture - Somatic embryogenesis, Anther culture and production of haploids.

Practical**8 hrs**

Preparation of media, sterilization, inoculation and callus induction (Demonstration only).

REFERENCES

1. Verma V 2007, Text Book of Plant Physiology. Ane Books Pvt. Ltd
2. Devlin & Witham – Plant Physiology (C B S publishers).
3. Kochhar P. L. & Krishnamoorthy H. N. – Plant Physiology. (Atmaram & Sons- Delhi, Lucknow).
4. Richard F Venn 2004, Principles and Practice of Bioanalysis, Taylor & Francis, Ane Books Pvt. Ltd
5. Kumar & Purohit – Plant Physiology - Fundamentals and Applications (Agrobotanical publishers]
6. Malic C. P. & Srivastava A. K. – Textbook of Plant Physiology (Kalyani Publishers- New Delhi).
7. Noggle G R & Fritz G J – Introductory Plant physiology (Prentice Hall of India).
8. Pandey S.N. & Sinha B. K. – Plant physiology (Vikas publishing House- New Delhi).
9. Salisbury F. B. & Ross C. W. - Plant physiology. (Wadsworth publishing company).
10. Sundara Rajan S . – College Botany Vol.IV (Himalaya publishing House).
11. William G. Hopkins – Introduction to Plant Physiology (John Wiley & Sons, New ork).
12. Freifelder D. - Physical Biochemistry W. H. Freeman
13. Erach Bharucha – Text book of environmental Studies for undergraduate Courses, Universities Press, University Grants Commission

14. Misra SP and Pandey SN, 2009, Essential Environmental studies, Ane Books Pvt Ltd.
15. Ahluwalia VK & Sunitha Malhotra 2009, Environmental science, Ane Books Pvt Ltd.
16. Sharma, P.D – Elements of Ecology (Rastogi's Company Ltd., Publications).
17. Vashista P.C – Plant Ecology Edu. Vishali Publications
18. Kumar. n 1999. An intro. To horticulture. rajalekshmi public. Nagarciol
19. Bose. t.k, j. kabir, p. das and pp. joy. 2001. Tropical horticulture. Naya prakash public. Culcutta
20. Desh beer singh & poonam wasir 2002 – bonsai – an art, scientific public. Jodhpur
21. Chaha, k.l 2001. Handbook of horticulture. Icar, delhi
22. Edwin biles, 2003. The complete book of gardening. Biotech.book. delhi
23. Bhattachargee. S.k 2006. Advances in ornamental horticulture. Pointer publications. Jaipur
24. Singh sp. 1999. Advances in horticulture and forestry. Scientific public. Jodhpur
25. Sharma. v.k. 2004. advances in horticulture, strategies production, plant protection and value addition – deep and deep public. Delhi
26. Gupta P. K. - Elements of Biotechnology (Rastogi publications).
27. Ignacimuthu S. J. – Applied Plant Biotechnology (Tata Mc Graw Hill)
28. Sobti RC and Suparna S Pachauri 2009, Essentials of Biotechnology, Ane Books Pvt. Ltd
29. Victoriano Valpuesta 2004, Fruit and Vegetable Biotechnology, CRC Press. New York. Ane Books Pvt. Ltd
30. Kumar H .D. - Molecular Biology & Biotechnology (Vikas publishing)
31. Pamela Peters – Biotechnology: A guide to genetic engineering (WC Brown publishers)
32. Ramawat K. G. – Plant Biotechnology (S. Chand & company)
33. Razdan M. K. – An introduction to Plant Tissue Culture (Oxford and I B H publishers)
34. Reinert J. and Bajaj Y. P. S – Plant cell, Tissue and Organ Culture (WC Brown publishers).