

**Vellalar College for Women (Autonomous), Erode - 12.**

**Master of Science in Botany**

**2016 - 2017 Onwards**

**Course Content and Scheme of Examinations (CBCS Pattern)**

**Semester I**

Study Components	Subject Code	Title of the Paper	Inst. Hrs./ Week	Exam. Dur. Hrs.	Max. Marks			Credits
					CIA	ESE	Total	
Core	16BOPC101	Paper I Microbes & Industry	5	3	25	75	100	4
	16BOPC102	Paper II Phycology, Bryology & Lichenology	5	3	25	75	100	4
	16BOPC103	Paper III Mycology & Phytopathology	5	3	25	75	100	4
	16BOPC104	Paper IV Pteridophytes, Gymnosperms & Palaeo botany	5	3	25	75	100	4
		Practical I Papers I, II, III & VI	7					
	16BOPN101	Non Major Elective	3	3	25	75	100	5
Total							500	21

**Semester II**

Core	16BOPC205	Paper V Anatomy & Embryology	6	3	25	75	100	4
	16BOPC206	Paper VI Cell Biology & Tissue culture	6	3	25	75	100	4
	16BOPC207	Paper VII Genetics, Germplasm Conservation & Plant Breeding	6	3	25	75	100	4
		Practical II Papers IV, V & VII	8					
	16BOPCP01	Practical I Papers I, II, III & VI (Exam)		4	40	60	100	3
	16BOPCP02	Practical II Papers IV, V & VII (Exam)		4	40	60	100	3
	13BOPS201	Skill Based Subject I	3	1*	40	60	100	5
	Library	1						
Total							600	23

\* Online Examination

**Vellalar College for Women (Autonomous), Erode - 12.**

**Master of Science in Botany**

**2016 - 2017 Onwards**

**NON MAJOR - ELECTIVE**

Subject	Subject Code	Title of the Paper
1	16BOPN101	Value Added Plant Science

**SKILL BASED SUBJECTS**

Subject	Subject Code	Title of the Paper
1	13BOPS201	Advanced Multi Skill Development Paper*
2	16BOPS302	Horticulture (Cafeteria)
3	16BOPS303	Green Medicine (Cafeteria)

**SELF LEARNING PAPER**

Subject	Subject Code	Title of the Paper
1	13BOPSL02	Wealth from wastes (optional)

\*Online examination for three units for a maximum of 60 marks.

Units IV & V are CIA for a maximum of 40 marks.

# SEMESTER – I

## Core Paper - I

### MICROBES AND INDUSTRY

Instructional Hrs. 75

Sub. Code: 16BOPC101

Max.Marks: CIA 25; ESE -75

Credits:

4

**Objectives:** To study the Classification - Characteristics & Structure of industrially important microbes. To study the isolation - Identification & Production of potential microbes in industries. To develop the skill of manufacturing industrial products.

#### UNIT - I

15 Hrs.

**Bacteria** - Classification of Bacteria (Bergey's, 1923) – Morphology and Ultra structure – Bacterial culture and cultural characteristics – Isolation and maintenance of pure culture – Growth curve of bacterial population - Quantitative measurement of bacterial growth – *Economic importance of bacteria*.

#### UNIT - II

15 Hrs.

**Viruses** - History of Viruses - Classification (Harrison *et al.*, 1971) – Structure of Virus - Double strand RNA and DNA viruses - Cauliflower Mosaic Virus – Wound Tumour Virus – Bacteriophages – Morphology – structure and replication – *HIV/AIDS Virus*.

#### UNIT - III

15 Hrs.

**Industrial microbiology** - Scope of industrial microbiology - Development of industrial fermentation process – Screening - Detection and assay of fermentation products - Stock culture - Fermentation media - Inoculum preparation- Scale up of fermentations - *Increasing product yield*.

#### UNIT - IV

15 Hrs.

**Fermentation techniques** – Types of Fermentation – Importance of microbial enzymes in industry – Industrial production of cellulolytic enzymes – Penicillin – Glutamic acid – Citric acid and *Vitamin B<sub>12</sub>*.

#### UNIT - V

15 Hrs.

**Microbiology of soil and water** – Rhizosphere and Mycorrhizae – factors affecting microbial community in soil. Types of water – Fresh water microbiology – *Purification of water*.

**Note:** Bold and *Italics* denote self study topics.

## **Practicals:**

### **Microbiology**

1. Inoculation of fungi and bacteria on selected media and maintenance of cultures.
2. Isolation of soil microbes (Bacteria and fungi) by dilution plating method using selective media.
3. Knowledge on anti-bacterial activity by using antibiotics.
4. Gram's staining
5. Test for coliform
6. Microbial screening – Photographs
7. SCP production - Photographs

### **REFERENCES:**

1. **Agarwal, A.K. and Parihar, P.**, "*Industrial Microbiology*", Shriya Computers and Printers, Jodhpur, 2006.
2. **Casida, L.E.**, "*Industrial microbiology*", Wiley Eastern Ltd., New Delhi, 1968.
3. **Chawla, D.S.**, "*Food feed and fuel from Biomass*", IBH, New Delhi, 1991.
4. **Patel, A.H.**, "*Industrial Microbiology*", Mac Millan India Ltd. New Delhi, 1984.
5. **Paul, A. Ketchum**, "*Microbiology*", John Wiley & Sons, USA., 1968.
6. **Pelczar, M.J. (Jr.), Chan, E.C.S. and Kreig, N.R.**, "*Microbiology*", Tata, Mc Graw Hill, New Delhi, 3<sup>rd</sup> Edition, 1993.
7. **Purohit, S.S.**, "*Microbiology - Microbiology Fundamentals and Applications*", Saraswathi, Purohit for Students Press, India, 2003.
8. **Michael, Pelczar, J., Chan Jr. E.C.S. and Krief, N.R.**, "*Microbiology*", Tata Mc Graw- Hill, New Delhi, 3<sup>rd</sup> edition, 1995.
9. **Smith, K.M.**, "*Viruses*", Cambridge University Press, 1974.

**SEMESTER – I**

**Core Paper – II**

**PHYCOLOGY, BRYOLOGY AND LICHENOLOGY**

**Instructional Hrs.: 75**

**Sub. Code:16BOPC102**

**Max. Marks: CIA 25; ESE -75**

**Credits:4**

**Objectives:** To understand the Range of thallus – Structure - Reproduction methods and life cycle pattern of lower plants and to understand the role of Lichens in human welfare.

**UNIT - I**

**15 Hrs.**

**ALGAE :** Classification of Algae (Fritsch, 1945)- Phylogeny and interrelationship - Range of thallus – *Pigmentation* - Reproduction and life cycle patterns of Chlorophyceae and Bacillariophyceae

**UNIT - II**

**15 Hrs.**

Comparative study of the range of structure – reproduction and life cycle pattern of - Phaeophyceae- Rhodophyceae – Cyanophyceae - Phylogeny and inter relationship- *Economic importance of Algae.*

**UNIT - III**

**15 Hrs.**

**BRYOPHYTES:** Classification (Reimer's ,1954) Origin– Distribution – Structure – Reproduction and life cycle of Hepaticae – Takakiales – Calobryales – Jungermanniales – Metzgeriales – Sphaerocarpaceae - Monocleales and *Marchantiales.*

**UNIT - IV**

**15 Hrs.**

Distribution – structure - reproduction and life cycle of Anthocerotae – Anthocerotales; Bryopsida - Sphagnales - Andreaeales – Funariales - Polytrichales – Fossil Bryophytes - *Economic importance .*

**UNIT - V**

**15 Hrs.**

**LICHENS :** Classification of Lichens (Hale, 1969) - Origin and evolution of lichens.Occurrence and Inter-relationship of Phycobionts and Mycobionts- Structure and Reproduction in

Ascolichens- Basidiolichens and Deuterolichens- Lichens as indicators of Pollution- ***Economic importance of Lichens.***

**Note: Bold and Italics denote self study topics.**

### **Practicals :**

**Phycology:** Gonium - Pediastrum – Hydrodictyon- Ulva - Bulbochaete – Cladophora - Pithophora –Stigeoclonium – Draparnaldia – Trentepohlia - Zygnema – Closterium – Nitella - Pinnularia – Sargassum - Padina – Turbenaria – Batrachospermum – Ceramium – Amphiroa - Gracillaria and Gelidium – Oscillatoria - Gloeocapsa – Lyngbya.

**Bryology:** Riccia - Targionia - Lunularia – Reboulia – Dumortiera - Aneura - Sphagnum and Bryum. **Lichenology:** Parmelia, Usnea

### **REFERENCES:**

1. **Bold, H.C., and Wyne, H.J.,** “*Introduction to the Algal structure and reproduction*”, Prentice Hall, Engle wood Cliffs, New Jersey, 1978.
2. **Chapman, V.J. and Chapman, P.J.,** “*The algae*”, The English language book society and Macmillen Publications, 1973.
3. **Fritsch, F.E.,** “*Structure and reproduction of the Algae*”. Vol. I, II & III, 1935-1945.
4. **Lee, R.E.,** “*Phycology*”, Cambridge University Publications, London,1987.
5. **Parihar, N.S.,** “*An introduction to bryophytes*” Vol. III. Central book Depot. Allhabad, 1967.
6. **Vashishta, B.R., Sinha, A.K. and Adarshkumar,** “*Botany for degree students – Bryophyta*”, S. Chand & Company Ltd., New Delhi, Revised Edition, 2008. 8.
7. **Frank Cavers** .The Inter Relationships of the Bryophyta, S.R.Technico Book house.1981
8. **Watson E.V.,** The Structure and life of Bryophytes. Hutchinson University Library, London, 1971.
9. **Prempuri,** Bryophytes; Morphology Growth and Differentiation. Atma Ram and Sons, 1986.
10. **Foster, A. S. and Gifford, E. M.** Comparative Morphology of Vascular Plants W.H. Freeman and Co.1973.

**SEMESTER – I**

**Core Paper – III**

**MYCOLOGY AND PHYTOPATHOLOGY**

**Instructional Hrs.:75**

**Sub. Code:16BOPC103**

**Max. Marks: CIA 25; ESE -75**

**Credits:4**

**Objectives:** To understand the range of thallus – Structure - Reproduction methods and life cycle pattern of Fungi and to understand plant – pathogen interaction

**UNIT - I**

**15 Hrs.**

**FUNGI :** Classification of fungi (Alexopoulos, 1962). Cell wall composition- mode of nutrition- Myxomycetes (Chytridiomycetes – Hypochytridiomycetes - Oomycetes - *Zygomycetes*).

**UNIT - II**

**15 Hrs.**

Range of Structure - Reproduction and Interrelationship of Ascomycetes (Hemiascomycetidae, Plectomycetidae, Hymenoascomycetidae and *Loculoascomycetidae*).

**UNIT -III**

**15 Hrs.**

Range of Structure - Reproduction and Interrelationship of Basidiomycetes and *Deuteromycetes*. Heterothallism - *Economic importance of fungi*.

**UNIT IV**

**15 Hrs.**

**Plant Pathology:** Classification of plant diseases – Principles of plant disease control - cultural, biological and chemical - Effect of environment on disease development. Causal organism, Symptoms, Disease cycle and control measures of little leaf of Brinjal, Black wart of Potato, *Blight of Paddy* and virus diseases of Potato.

**UNIT V**

**15 Hrs.**

**Pathogenesis:** Penetration and entry - Enzymes in plant disease – cell wall degrading enzyme. *Toxins*, Dissemination of Plant pathogens - Defense mechanism .

**Note: Bold and Italics denote self study topics.**

## **Practicals :**

**Mycology :** Albugo – Saprolegnia – Rhizopus - Mucor – Saccharomyces – Ascobolus – Pezzia -  
Puccinia - Agaricus – Polyporus-Lycoperdon-Alternaria-Fusarium-Cercospora

## **Phytopathology:**

1. Estimation of total chlorophyll in infected and healthy plants.
2. Causal agent, symptoms and control measures of Black wart of Potato, little leaf of Brinjal, Blight of Paddy and Virus diseases of Potato.
3. Anatomical studies of infected regions.
4. Comparison between infected and healthy plants with reference to total carbohydrate and Protein.

## **REFERENCES:**

1. **Alexopoulos, C.J. and Mims C.W.**, *“Introductory Mycology”*, Wiley Eastern PVT., LTD., New Delhi, Second Edition, 1962.
2. **Ainsworth, S.C., Sparrow, F.E. and Sussman, A.D.**, *“The fungi and advanced treatise”*, Vol. I, II, III, IVA & IVB.
3. **Vashishta, B.R., Sinha, A.K.**, *Fungi Botany for degree students.S. Chand & co, New Delhi, 2007.*
4. **Mehrotra, R.S and Aneja, K.R.** An introduction to Mycology. New age international Pvt.Ltd. Mumbai, 1998.
6. **Agrios, George, N.**, *“Plant Pathology”*, Academic Press, Sandiego, London. 1988.
7. **Aneja, K.R.**, *“Experiments in Microbiology, Plant Pathology and Tissue culture”*, Wishwa Prakashan, New Delhi, 1996.
8. **Baker, F and Cook, R.J.**, *“Biological control of plant pathology”*. Chand and Company LTD., New Delhi, 1979.
9. **Bilgrimi, K.S. and Dube, H.C.**, *“A text book of Modern Plant Pathology”*, Vikas Publishing House, PVT., LTD., Kanpur, 1980.
10. **Mehrotra, R.S.**, *“Plant Pathology”*, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 1996.



**SEMESTER – I**

**Core Paper – IV**

**PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY**

**Instructional Hrs: 75**

**Sub. Code: 16BOPC104**

**Max. Marks: CIA 25; ESE -75**

**Credits: 4**

**Objectives:** To know gametophytic and sporophytic structural variations in Pteridophytes and Gymnosperms

**UNIT - I**

**15 Hrs.**

Classification of Pteridophytes (Reimer's, 1954) - Telome concept - Apospory - Morphology - anatomy and reproduction of - *Psilotales* - Selaginellales – Isoetales – Marattiales.

**UNIT - II**

**15 Hrs.**

Morphology - anatomy and reproduction of – Ophioglossales – Osmundales - Filicales – *Salviniales* - Sorus evolution.

**UNIT - III**

**15 Hrs.**

Classification of Gymnosperms (Sporne, 1965), General account of Bennettitales – Pentoxylales - *Cycadales* – Ginkgoales.

**UNIT - IV**

**15 Hrs.**

General account of Coniferales (Cupressaceae – Podocarpaceae – Araucariaceae - Pinaceae) Taxales - Gnetales - *Angiospermic characters*.

**UNIT - V**

**15 Hrs.**

**Fossils: Types of fossils-** process of fossilization and importance of fossils - Detailed study of the fossil forms – Pteridophytes- Rhynia- Lepidodendron – Calamites – Sphenophyllum – Gymnosperms - Lyginopteris - Cordaites.

**Note: Bold and Italics denote self study topics.**

## **Practicals :**

**Pteridophytes:** Psilotum- Selaginella – Angiopteris – Osmunda – Dicranopteris – Lygodium – Pteris – Alsophila – Nephrolepis - Salvinia and Azolla.

**Gymnosperms:** Pinus, Gnetum, Cupressus – Podocarpus – Araucaria - Ephedra.

**Fossils:** Rhynia – Lepidodendron , Stigmaria, Sphenophyllum – Calamites.

Gymnosperms: Lyginopteris - Lagenostoma - Pentoxylon – Cordaites.

## **REFERENCES:**

1. **Rashid.A. 2007.** An Introduction to Pteridophyta - Vikas publications, New Delhi.
2. **Sporne, K.R. (1975).** The Morphology of Pteridophytes, Hutchinsonand Co., London.
3. **Foster, A. S. and Gifford, E. M.** Comparative Morphology of Vascular Plants. W.H. Freeman and Co.1973.
4. **Johri, RM, Lata S, Tyagi K (2005),** A text book of Gymnosperms, DominatePub and Distributor, New Delhi.
5. **John M. Coulter and Chamberlin C.J.,** “ *Morphology of Gymnosperms*”, Central book Depot., Allahabad, 1917.
6. **Vasishta, P.C., Sinha,A.K. and Anilkumar,** Botany for Degree Students Gymnosperms.S.Chand & co, New Delhi. 2006.
7. **Chester A. Arnold,** “ *An introduction to Palaeobotany*”, Agrobios (India), Jodhpur, 1947.

# SEMESTER – I

## Non Major Elective

### VALUE ADDED PLANT SCIENCE

Instructional Hrs.45

Sub. Code: 16BOPN101

Max. Marks: CIA 25; ESE -75

Credits: 5

**Objectives:** To enable the other Department students to have basic knowledge on plant science.

To develop entrepreneurial skill and health awareness using herbs.

#### UNIT - I

9 Hrs.

**Gardening** - Garden styles, Kitchen garden - Roof garden - Miniature water garden - Rockery and *Hanging basket* .

#### UNIT - II

9 Hrs.

**Asexual Propagation & Flower arrangement** - Types of asexual propagation: Layering – Grafting. Hydroponics – Bonsai - *Flower arrangement*.

#### UNIT - III

9 Hrs.

**Single cell protein** - Cultivation and Nutritive value - *Spirulina* - Yeast - Mushroom cultivation and *Nutritive values* – Oyster mushroom - White button mushroom.

#### UNIT - IV

9 Hrs.

**Biofertilizer** - Rhizobium - mass cultivation and uses. Vermicomposting - Study of Earth worm (*Eisenia* and *Lampito*). Preparation of Vermicomposting. Vermiwash Production techniques. *Role of vermicompost in agriculture*.

#### UNIT -V

9 Hrs.

**Nutraceuticals**- Food as medicine-Nutritive value of fruits – Preparation of Home medicines – Tulsi water – *Hibiscus* syrup, *Arugampul juice*.

**Note: Bold and Italics denote self study Topics.**

## REFERENCES:

1. **Arvind Kumar**, "*Verms and Vermitechnology*" APH Publishing Corporation New Delhi 2005.
2. **Chattopadhyay, P.K.**, "*Herbal Cosmetics and Ayurvedic medicines*", National Institute of Industrial Research , New Delhi.2008.
3. **Farooqi, A.A. and Sreeramu, B.S.**, "*Cultivation of Medicinal and Aromatic Crops*", University Press, Bangalore, 2004.
4. **Gupta, P. K.**, "*Vermicomposting*", Agrobios Publishers, New Delhi, 2003.
5. **Kumaresan, V.**, "*Biotechnology*", Saras Publications, India, 2005.
6. **Palaniyappan, P. and Annadurai, K.**, "*Organic Farming Theory and Practice*", Scientific Publishers, India, 2003.
7. **Panda H.** , "*The Complete technology books on herbal Beauty with formulations & Process*" Asia pacific Business press. Inc., New Delhi.
8. **Panda H.**, *Herbal Cosmetics-HandBook.*,Asia Pacific Business Press Inc.New Delhi
9. NIIR Board of Consultants and Engineers, Cultivation of fruits, vegetables and floriculture, National institute of industrial research, New Delhi.

## SEMESTER – II

### Core Paper -V

#### ANATOMY AND EMBRYOLOGY

**Instructional Hrs.: 90**

**Sub. Code: 16BOPC205**

**Max.Marks:CIA 25;ESE -75**

**Credits:4**

**Objectives:** To study Histological and Pharmacognostical tools for identification of plants. To understand the anomaly existing in Dicot and Monocot angiospermic plants. To study the developmental stages in Angiosperms. Histological tools for identification of plants.

#### **UNIT- I**

**18 Hrs.**

**Tissues-** Meristem – Types- Shoot apex- Root apex. Vascular cambium – origin – types – structure and Functions – Phylogenetic trends of specialization of xylem and phloem. Secondary xylem and *Secondary phloem*.

#### **UNIT- II**

**18 Hrs.**

Epidermis – Types – wall structure – *stomata* – epidermal appendages – Periderm - Leaf Histology – ontogeny – Development of Dicot and Monocot Leaves – Leaf Abscission- Nodal Anatomy. Anatomy in relation to Taxonomy.

#### **UNIT- III**

**18 Hrs.**

**Anomalous secondary thickening** - Bignoniaceae – Amarantaceae – Aristolochiaceae - Nyctaginaceae and Piperaceae – *Arborescent monocots*.

#### **UNIT-IV**

**18Hrs.**

**Embryology-** Anther – Morphology - Tapetum – ultra structure- types and functions. Male gametophyte-development. Female Gametophyte – Types- ultra structure – development – Synergids- Nutrition of embryo sac - fertilization and *double fertilization*.

#### **UNIT- V**

**18 Hrs.**

Endosperm – Types and development. Endosperm haustoria – function - storage metabolites- Embryo – Development of a typical Monocot and Dicot embryo – Polyembryony- Apomixis and *Parthenocarpy*.

**Note: Bold and Italics denote self study topics.**

## **Practicals:**

### **Anatomy**

Study of anatomical features with the help of section – peelings and macerations included in the syllabus

### **Embryology**

With the help of permanent slides/book diagrams to study

1. Stages in development of micro sporangium and male gametophyte.
2. Configuration of ovules 2, 4, nucleate embryo sac, mature embryo sac.
3. Types of endosperm
4. Stages in embryogeny globular, proembryo matured embryo of Dicot (dissection)
5. Pollen germinability

## **REFERENCES:**

1. **Eames, A.J., and Daniel, M.C.**, “An introduction to plant anatomy”, TATA Mc Graw – Hill-Publishing House LTD.,1976.
2. **Pandey, B.P.**, “*Plant Anatomy*”, S. Chand and Company LTD., New Delhi,1978.
3. **Raghavan, V.**, “*Experimental embryogenesis in Vascular plants*”, Academic Press, London, 1976.
4. **Austin**, “*Fertilization*”, Prentice Hall of India, New Delhi,1968.
5. **Bhojwani S.S. and S.P. Bhatnagar**, “*The embryology of angiosperms*”, Vikas publishing House Pvt. Ltd, New Delhi, 1985.
6. **Johri, B.M.**, “*Experimental embryology of vascular plants*”, Narasu Publications house, New Delhi, 1982.
7. **Maheswari, P.**, “*Introduction to the embryology of Angiosperms*”, Mc Graw Hill Book Co. Inc., New York, 1958.
8. **Raghavan, V.**, “*Experimental embryogenesis in vascular plants*”, Academic Press, London, 1976.
9. **Shivanna, K.R. and B.M. Johri**, “*The angiosperm pollen structure and functions*”, Wiley–Eastern Ltd., 1985.

## SEMESTER – II

### Core Paper –VI

#### CELL BIOLOGY AND TISSUE CULTURE

**Instructional Hrs.:90**

**Sub. Code: 16BOPC206**

**Max.Marks:CIA25;ESE-75**

**Credits:4**

**Objectives:** To comprehend the structure of cell organelles. To understand the structure and replication of nucleic acid .To develop the skill of in *vitro* propagation and application in horticulture and forestry.

#### UNIT- I

**18 Hrs.**

**Cell Organelles-** Cell-ultra structure - Cytoplasmic organelles - origin-structure and function of Mitochondria-Golgi apparatus- Plastids- Ribosome- Dictyosome - Glyoxysome and *Peroxisome*.

#### UNIT- II

**18 Hrs.**

Plasma membrane- Ultra Structure and functions. Cell wall- primary- secondary and tertiary at microscopic and submicroscopic levels. Chemistry of cell wall- Structure and functions of nucleus- nuclear envelope and *nucleolus*- Chromosomes – ultra structure and function, specialized chromosomes-polytene and lamp brush .

#### UNIT- III

**18 Hrs.**

**Cell divisions-** Mitosis- mitotic apparatus and its significance. *Meiosis and its significance*. DNA – Structure (Watson and Crick model) - replication - termination of replication -Role of Enzymes in DNA replication - Methylation and Repair mechanism. Types of DNA - Mitochondrial and chloroplast DNA. Types and synthesis of RNA.

#### UNIT- IV

**18 Hrs.**

**Tissue culture** – Concepts and Applications – *Basic steps* (Preparation of media- sterilization – inoculation – incubation – regeneration - hardening and plantlet transfer) Type of cultures – callus and suspension culture Meristem culture, Protoplast isolation and culture - Hybrids and Cybrids- Somatic hybridization.

## UNIT- V

18 Hrs.

Somaclonal variation- Somatic embryogenesis- Haploid production- and Embryo culture-Synthetic seed - Cryopreservation-Application of tissue culture in Agriculture- Horticulture and *Forestry*.

**Note: Bold and *Italics* denote self study topics.**

### **Practicals :**

#### **Cell biology**

1. Study of meiosis using smears - Individual
2. Interpretation of micrographs from standard purchased materials or from transparencies.

#### **Tissue Culture**

Preparation of stock solution- sterilization- inoculation- nutrient media- organ culture- Morphogenesis- Induction of callus- Group Practical

Synthetic seed preparation - Individual

### **REFERENCES:**

1. **Archana Sharma**, "*Chromosomes*", Oxford and IBH Publishing Company , 2<sup>nd</sup> Ed., 1985.
2. **Freifelder, D.**, "*Molecular Biology*", Narosa publishing house, New Delhi, 2<sup>nd</sup> Ed.,1983.
3. **Verma P.S.** and **Agarwal V. K.**, "*Cytology*", Chand and company Ltd., Publications, New Delhi,1978.
4. **Young, W.J.**, "*Cytogenetics*", Prentice Hall India, Pvt. Ltd. 2<sup>nd</sup> Ed., 1988.
5. **Watson, J.D.** and **Benjamine W.A.** , "*Molecular Biology of the genes*", 3<sup>rd</sup> Ed.
6. **De Robertis, E.D. P.**, **Wiktor, W. Nowinski & Francisco A. Saez** "*Cell Biology*" W.B Saunders Company, London and Toppon Company Ltd., Japan.
7. **Kumar, N.C.**, "*An Introduction to Plant Tissue and Cell Culture*", Emkay Publications, New Delhi, 1994.
8. **Razdon, M.K.**, "*Introduction to plant tissue culture*", second Edition. Oxford IBH Publishing co. PVT., LTD., New Delhi,1995.
9. **Singh, Seema Srivastava**, "*Plant tissue culture*", Campus books International, New Delhi, 2006.



## SEMESTER – II

### Core Paper -VII

#### GENETICS, GERMPLASM CONSERVATION AND PLANT BREEDING

**Instructional Hrs.: 90**

**Sub. Code: 16BOPC207**

**Max.Marks: CIA 25; ESE -75**

**Credits:4**

**Objectives:** To discern the genetical disorders in life forms. To understand the regulation of gene expression. To know the hybridization methods and techniques in crop plants.

#### UNIT-I

**18Hrs.**

**Interaction of genes** – Lethal factors- Modifying factors- collaborative factors. Co dominance - Quantitative inheritance - sex determination in plants- Theories of sex determination (theory of Heterogametic&Genic balance)-Sex limited characters- *Sex influenced characters*.

#### UNIT-II

**18Hrs.**

**Gene mutation** - Detection of mutation (CLB Method - Muller 5 method). Physical and chemical mutagens and their mode of action. Eugenics- Euthenics- genetic disorder of chromosomal and genic origin. Extrachromosomal inheritance - Uniparental inheritance in Chlamydomonas and Yeast-*Male sterility in Maize*.

#### UNIT- III

**18 Hrs.**

**Population genetics** – gene frequency –Hardy Weinberg law, *Genetic drift*-Modern concept of genes- Structure of gene-IS Element and Transposons- Regulation of gene expression in Prokaryotes and Eukaryotes Artificial synthesis of gene.

#### UNIT -IV

**18 Hrs.**

**Germplasm conservation**- World diminishing plant resources-*Threatened and endangered plants*- Red Data Books- The role of IBPGR (Rome, Italy) and NBPGR (New Delhi) in Germplasm Conservation - Patent and Intellectual Property Rights (IPR).

**Plant breeding** – Objectives, breeding methods in self-fertilized - cross fertilized and vegetatively propagated plants-Breeding plants for improving yield and quality and resistant to diseases- *Distant hybridization in Plant breeding*.

**Note: Bold and *Italics* denote self study topics.**

**Practicals:**

**Solving Problems involving:**

1. Interactions of factors
2. Sex linked inheritance
3. Quantitative inheritance
4. Calculation of gene frequencies
5. Training in hybridization techniques

**REFERENCES:**

1. **Arnold, R.W.**, “*Principles of Plant Breeding*”, John Willey & Sons, 1960.
2. **Gilber, N.W.**, “*Organellar Heredity*”, Revan Press, New York, 1978.
3. **Gupta, P.K.**, “*Genetics*”, Rastogi Publication, Meerut, India, 1994.
4. **King, R.C.** , “ *A Hand book of Genetics*”, Plenum Press, New York, 1994.
5. **Singh, B.D.**, “*Plant Breeding: Principles and Methods*”, Kalyani Publishers, 2008.
6. **Singh, B.D.**, “*Genetics*”, Kalyani Publishers, 2008.
7. **Swaminathan, M.S. and Jana. S.**, “*Biodiversity*”, Mac Millan, India Press, Madras, 1992.
8. **Verma P. S. and Agarwal , V.K.**, *Genetics*, S. Chand & Co, New Delhi, 2006.

## SEMESTER II

### Skill Based Subject - I

#### ADVANCED MULTI SKILL DEVELOPMENT PAPER

Instructional Hrs.: 45

Sub. Code:13BOPS201

Max.Marks: CIA 40; ESE -60

Credits:5

**Aim:** To equip the students with knowledge on all topics as desirable from the point of view of brilliant success in the competitive examinations.

**Objectives:** To familiarize the students with various types of tests that are employed by the diverse examining bodies.

#### UNIT -I

9 hrs.

**Communication-** Question tags - Gerund and Infinitives - Spotting the errors – Synonyms – Antonyms - One word substitution – Sentence completion –Prepositions – Articles.

**General Awareness and Scientific Aptitude:** Socio - Economic - Banking – Basic Sciences People and Environment.

Politics and Current Affairs

Higher Education.

Information and Communication Technology.

Teaching Aptitude.

Research Aptitude.

#### UNIT- II

9 hrs.

**Logical Reasoning :** Syllogism – Statement Conclusions – Statement Arguments – Statement Assumptions – Statement Courses of Action – Inference – Cause and Effect – Visual Reasoning – Direction Sense Test – Blood Relation – Coding and Decoding – Deductive Reasoning.

#### UNIT- III

9 hrs.

**Numerical Reasoning and Quantitative Aptitude:** Age – speed – Heights and Distance – Time and Distance - Ratio and Proportion – Percentage – Fraction – Profit and Loss – Interest – Average – Calendar – Clocks– Probability – Series – Venn Diagram - Data Interpretation.

#### UNIT -IV

9 Hrs.

Power point presentation – Meiosis- Mutation- Grafting- Layering- *Ex-situ* Conservation- *In-situ* Conservation- Green house effect- Global warming and Acid rain.

**UNIT- V**

**9 Hrs.**

Interview types –One to one- one to panel- Interview skills-Verbal- Greeting- Speaking.

Non –Verbal –movement- posture- gesture- eye contact- Voice modulation- Dress code- Space and proximity.

**REFERENCES:**

1. **Agarwal.R.S**, *Quantitative Aptitude*, S. Chand and Company, Reprint 2012.
2. **Chopra.J.K**, *Bank Probationary Officers' Examination*, Unique Publishers, 2010.
3. **Datason. R.P, Manish Arora and Gulati.SW.L**, *Clerical Cadre Recruitment in State Bank of India*, Newlight Publishers, 2013.
4. **Davinder Kaur Bright**, *Railway Recruitment Board*, Bright Publications, 2010.
5. **Lal, Jain and Vashishtha, K.C**, *UGC NET/JRF/SET Teaching and Research Aptitude*, Upkar Prakashan Publishers, 2012.
6. **Pratyogita Darpan**, *UGC NET/JRF/SET Teaching and Research Aptitude*, Upkar Prakashan Publishers, 2012
7. **Sharma.J.K**, *IBPS Recruitment of Bank Clerical Cadre Examination*, Unique Publishers, 2013.
8. **Tara Chand**, *General Studies for Civil Services Preliminary Examinations*, Paper – I, Tata Mc Graw Hill Education Private Ltd, 2013.
9. **Hari Mohan Prasad and Uma Rani Sinha**. 2011. *Objective English for Competitive Examinations*. New Delhi: Tata McGraw Hill Education Private Ltd.
10. **Jain T.S**. *Upkar's SBI Clerical Cadre Recruitment Examination*. Agra: Upkar Prakashan.

**VELLALAR COLLEGE FOR WOMEN (AUTONOMOUS) ERODE-12.**

**M.Sc. DEGREE PRACTICAL EXAMINATIONS**

**Model Paper- Core Practical-I**

**MICROBES &INDUSTRY, PHYCOLOGY, BRYOLOGY, LICHENOLOGY, MYCOLOGY,  
PHYTOPATHOLOGY, CELL BIOLOGY AND TISSUE CULTURE**

**Hrs:4**

**Sub.Code:16BOPCP01**

**Max. Marks: CIA 40;ESE -60**

**Credits:3**

- |      |  |                  |
|------|--|------------------|
| I.   | Analyse the Algal mixture <b>A</b> . Identify two genera.  | <b>2 x 3 = 6</b> |
| II.  | Make suitable preparations of <b>B &amp; C</b> . Identify by salient features. Draw labelled sketches. Leave the slides for valuation. | <b>2 x 6 =12</b> |
| III. | Estimate Chlorophyll of given sample <b>D</b> .Write the procedure and draw the inference  | <b>4</b>         |
| IV.  | Make suitable micro preparations of <b>E</b> . Draw labelled diagrams of any 2 stages and leave the slide for valuation.               | <b>2 x 2 =4</b>  |
| V.   | Identify the given specimen <b>F</b> . Write the Causal agent, Symptoms and Control measures   | <b>4</b>         |
| VI.  | Identify the following with reasons and draw labelled sketches of <b>G, H, I, J&amp;K</b>  | <b>5 x 4 =20</b> |

**Record**

-----  
**50**  
**10**  
-----

**Total**

**60**  
-----

**CORE PRACTICAL – I**  
**SCHEME OF VALUATION**

**Time : 4 hrs.**

**Maximum : 60 marks**

I.	<b>A</b>	- Algal Mixture	Identification -1, Sketch – 1, Notes -1	<b>2 x 3 = 6</b>
II	<b>B</b>	- Bryophytes		
	<b>C</b>	-Mycology	Identification -1, Description – 2, Sketch – 1, Slides -2	<b>2 x 6= 12</b>
III.	<b>D</b>	-Chlorophyll Estimation	Procedure-2,	Inference-2
<b>4</b>				
IV.	<b>E</b>	Meiosis	Slides -1	<b>2 x 2= 4</b>
			Sketch – 1	
V	<b>F</b>	- Pathology	Identification– 1,Causal Organism-1, Symptoms – 1 & Control Measures-1	
<b>4</b>				
VI	<b>G</b>	-Bacteria / Virus / Industrial Microbiology		
	<b>H</b>	- Mycology		
	<b>I</b>	- Lichenology		
	<b>J</b>	- Cell biology		
	<b>K</b>	- Tissue Culture	Identification -1, Sketch -1, Reasons-2	<b>5x 4 =20</b>
				-----
				<b>50</b>
			Record	<b>10</b>
				-----
			Total	<b>60</b>
				-----

**VELLALAR COLLEGE FOR WOMEN (AUTONOMOUS) ERODE-12.**

**M.Sc. DEGREE PRACTICAL EXAMINATIONS**

**Core Practical - II**

**PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, ANATOMY, EMBRYOLOGY,  
GENETICS, GERMPLASM CONSERVATION AND PLANT BREEDING**

**Hrs: 4**

**Sub. Code:16BOPCP02**

**Max. Marks: CIA 40;ESE -60**

**Credits:3**

1.	Make suitable micropreparation of <b>A , B &amp; C</b> . Identify by salient features. Draw labelled sketches. Leave the slides for valuation.	<b>3 x 7 = 21</b>
II.	Dissect & display any two stages of the embryo from the material <b>D</b> . Submit the slide for valuation.	<b>2 x 3 = 6</b>
III.	Work out the genetic problem <b>E</b> .	<b>5</b>
IV.	Write notes of interest on <b>F, G, H, I, J &amp; K</b>	<b>6 x 3 =18</b>
		----- <b>50</b>
	<b>Record</b>	<b>10</b>
		-----
	<b>Total</b>	<b>60</b>
		-----

**CORE PRACTICAL – II**  
**SCHEME OF VALUATION**

**Time : 4 hrs.**

**Maximum : 60 marks**

I.	A	- Pteridophytes	
	B	- Gymnosperms	
	C	- Anatomy	
		Identification -1, Description – 2, Sketch – 2, Slide -2	<b>3 x 7 = 21</b>
II			
	D	- Embryo dissection	
			<b>2 x 3= 6</b>
III	E	- Genetic Problem	<b>5</b>
IV.	F	- Pteridophytes	
	G	- Gymnosperms	
	H	- Palaeobotany	
	I	- Anatomy	
	J	- Embryology	
	K	- Plant breeding	
		Identification -1, Sketch -1, Reasons - 1	<b>6x 3 = 18</b>
			-----
			<b>50</b>
			Record <b>10</b>
			-----
			Total <b>60</b>
			-----



## **SELF LEARNING PAPER - I**

### **WEALTH FROM WASTES**

**Sub. Code: 13BOPSL02**

**Max.Marks: 100**

**Credits: 5**

#### **Objectives:**

Gaining momentum in the millennium by utilizing the available wastes and channel them towards economic activities.

#### **UNIT I**

Organic wastes – Compost making – Different methods, sources of Biogas generation (Animal, Human, Agriculture, Aquatic & Industrial wastes).

#### **UNIT II**

Biomedical wastes – Sources, types, Disposal methods, segregation, Recycling – composting, Incineration.

#### **UNIT III**

Coir wastes in Agriculture – Coir waste compost – Composition, Coirwaste briquetting, application of briquetting. Coirwaste in Poultry and Crop Production, Coir waste as mulch and rooting medium.

#### **UNIT IV**

Agricultural wastes – Paper manufacturing – Kinds of agricultural wastes, operations in paper and paper board making. Sugarcane wastes – Pressmud – Bioearth, Sugarcane trash composting, creating art objects, Mushroom cultivation.

#### **UNIT V**

Sewage water – Utilization sewage water, sewage treatment, Treatment of Effluent – Paper mill, Distillery, Vermi Composting.

## References:

1. **Asthana, D.K. and Meera Asthana**, "*Environment Problems and Solutions*", S.Chand and Company Ltd. First Edition, 2002.
2. **Dubey, R.C.**, "*A text book of Biotechnology*", S. Chand and Company,2001.
3. **Kumaresan, V.**, "*Biotechnology*", Saras Publication, Chennai, 2005.
4. **Narayana Rao, M. and Amal K. Dutta**, "*Waste water treatment*", Oxford IBH Publishing Co. Pvt. Ltd. New Delhi, second edition, 2003.
5. **Palaniappan, S.P. and K. Annadurai**, "*Organic farming theory and practice*", Scientific Publications, Jodhpur, India. 2003.
6. **Sakharkar, B.M.**, "*Principles of Hospital Administration and Planning*", First Edition, Published by Jaype Brothers, 2003.
7. **Sathe, T.V.**, "*Vermiculture and Organic farming*", Daya Publishing house, New Delhi, 2004.

Vellalar College for Women (Autonomous), Erode - 12.								
Master of Science in Botany								
2016 - 2017 Onwards								
Course Content and Scheme of Examinations (CBCS Pattern)								
Semester III								
Study Components	Subject Code	Title of the Paper	Inst. Hrs./ Week	Exam. Dur. Hrs.	Max. Marks			Credits
					CIA	ESE	Total	
Core	16BOPC308	Paper VIII Taxonomy & Biosystematics	5	3	25	75	100	4
	16BOPC309	Paper IX Plant Physiology & Phytochemistry	6	3	25	75	100	4
	16BOPC310	Paper X Bioinformatics	5	3	25	75	100	4
	16BOPS302	Skill based subject II	3	3	25	75	100	5
	16BOPS303	Skill based subject III	3	3	25	75	100	5
			Practical III Papers VIII, XI & XII	8				
Total							500	22
Semester IV								
Core	16BOPC411	Paper XI Genetic Engineering & Biotechnology	6	3	25	75	100	4
	16BOPC412	Paper XII Ecology & Conservation Biology	5	3	25	75	100	4
	16BOPC413	Paper XIII Research Methodology	5	3	25	75	100	4
			Practical IV Papers IX, X & XIII	8				
	16BOPCP03	Practical - III Papers VIII, XI & XII (Exam)		4	40	60	100	4
	16BOPCP04	Practical IV Papers IX, X & XIII (Exam)		4	40	60	100	4
	11BOPC4PV	* Project	5			100	100	4
			Library	1				
Total							600	24
Grand Total (I to IV Semesters)							2200	90
*A Project Viva - voce is conducted at the end of IV Semester. Project evaluation to be done by both Internal & External examiners. 80 Marks for Project, 20 Marks for Viva voce.								

<b>Vellalar College for Women (Autonomous), Erode - 12.</b>			
<b>Master of Science in Botany</b>			
<b>2016 - 2017 Onwards</b>			
<b>NON MAJOR - ELECTIVE</b>			
Subject	Subject Code	Title of the Paper	
1	16BOPN10 1	Value Added Plant Science	
<b>SKILL BASED SUBJECTS</b>			
Subject	Subject Code	Title of the Paper	
1	13BOPS20 1	Advanced Multi Skill Development Paper*	
2	16BOPS30 2	Horticulture (Cafeteria)	
3	16BOPS30 3	Green Medicine (Cafeteria)	
<b>SELF LEARNING PAPER</b>			
Subject	Subject Code	Title of the Paper	
1	13BOPSL0 2	Wealth from wastes (optional)	
*Online examination for three units for a maximum of 60 marks.			
Units IV & V are CIA for a maximum of 40 marks.			

## SEMESTER – III

### Core Paper - VIII

#### TAXONOMY AND BIOSYSTEMATICS

**Instructional Hrs.:75**

**Sub. Code:16BOPC308**

**Max.Marks: CIA 25;ESE -75**

**Credits:4**

**Objectives:** To conserve the biodiversity. To identify the locally available plants. To understand the relationship of Taxonomy with other fields of Biological science.

#### UNIT- I

**15 Hrs.**

**Systems of classification-** Artificial – Linnaeus - Natural – Bentham and Hooker Phylogenetic – Engler and Prantl - Modern – Cronquist – Merits and demerits-International Code of Botanical Nomenclature – Typification - Principles of priority and their limitations. Effective and valid publications - *citation*-retention - choice and rejection of names.

#### UNIT- II

**15 Hrs.**

Flora- Monograph - Revision - Keys - Modern trends in Taxonomy- External morphology - Anatomy- Embryology-Palynology- Cytology- Chemotaxonomy - *Botanic gardens*

#### UNIT- III

**15 Hrs.**

**Families-**Systematic Position - Description and Economic uses of the following families Menispermaceae – Polygalaceae – Caryophyllaceae – Portulacaceae - Oxalidaceae – Meliaceae –Vitaceae – Rhamnaceae – Sapindaceae - Fabaceae – *Caesalpinaceae* – Mimosaceae - Rosaceae – Onagraceae – Lythraceae - Aizoaceae.

#### UNIT- IV

**15 Hrs.**

Oleaceae – Gentianaceae – Apocynaceae - *Solanaceae* – Boraginaceae – Bignoniaceae – Pedaliaceae - Nyctaginaceae – Aristolochiaceae - Loranthaceae - Scitamineae - Commelinaceae - Aroideae – Cyperaceae.

#### UNIT- V

**15 Hrs.**

**Biosystematics-** Its aim and scope. Phenotypic plasticity. Turreson's work. Ecological differentiation- *Gene ecology*- Numerical taxonomy.

**Note: Bold and Italics denote Self Study Topics.**

## Practicals

1. Study of the Taxonomical characters of the above mentioned families with economic importance
2. Preparation of artificial key
3. Submission of herbarium sheets – No. 40.
4. Field trip for 5 Days
5. Visit to BSI / Nilgiri Biosphere National Park

## REFERENCES:

1. **Bennet, S.S.R.**, “*An Introduction to Plant Nomenclature*” International Book Distribution, India, 1989.
2. **Davis & Hey wood**, “*Principles of angiosperm taxonomy*” Today and Tomorrow’s Printers And Publishers, New Delhi, Revised Edition, 1965.
3. **Heslop J. Herrison**, “*New concepts in flowering plants taxonomy*”, Heinemann Educational Books, India, Revised Edition, 1970
4. **Lawrence H.M.**, “*Taxonomy of Vascular plants*”, Mac Millan & Co, New Delhi, 1979.
5. **Rendle A.R.**, “*A Classification of flowering plants*”, Vol. I and II., Cambridge University Press, 1979.
6. **Sokal S.R.** and **Sneath P.H.**, “*Principles of Numerical Taxonomy*”, N.H. Freeman & Co. 1977.
7. **Solbig**, “*Principles and methods of plant Biosystematics*”, The Mac Millan Company, New Delhi, 1985.
8. **Stace Clive A.**, “*Plant Taxonomy and Biosystematics*”, Edward Arnold, London, Second Edition, 1989.
9. **Attwood, T.K.** and **Parry Smith, D.J.**, “*Introduction to Bioinformatics*”, Pearson Education Ltd., Fifth edition, New Delhi, 2003.

## SEMESTER – III

### Core Paper - IX

#### PLANT PHYSIOLOGY AND PHYTOCHEMISTRY

Instructional Hrs.:90

Sub. Code: 16BOPC309

Max.Marks: CIA 25; ESE -75

Credits:4

**Objectives:** To learn the metabolic and biochemical reactions in plants.

To understand the movement of water and solute.

To enhance the technical skill in fruit development and fruit ripening

#### UNIT-I

18Hrs.

**Water-** Structure- Properties- Biological significance- Water potential. A General account of absorption and translocation of water- solutes and assimilates. *Transpiration* and stomatal mechanism- Enzyme: Classification-Properties and mechanism of enzyme action.

#### UNIT- II

18 Hrs.

**Photosynthesis- *Photosynthetic pigments***- Mechanism of Photosynthesis: Light reaction. Electron carriers- photophosphorylation- Carbon fixation in C<sub>3</sub> and C<sub>4</sub> plants- CAM pathway. Photorespiration and glycolate- metabolism.

#### UNIT- III

18 Hrs.

**Respiration-** Glycolysis- Pyruvate metabolism. TCA cycle- Electron transport system coupled with Oxidative phosphorylation- Metabolism of storage protein and fat to carbohydrates-*HMP pathway*.

#### UNIT- IV

18 Hrs.

**Growth hormones-** General account of Auxin- Gibberellins- Cytokinins- Ethylene - Abscissic acid. Senescence- Phytochrome- Photoperiodism- Vernalisation-*Biological clock*.

#### UNIT- V

18 Hrs.

**Biomolecules** - Classification- structure and properties of carbohydrates- amino acids- proteins and lipids - secondary metabolites and *antioxidant activity* (outline only).

**Note: Bold and *Italics* denote Self Study Topics.**

## **Practicals:**

### **a. Plant Physiology**

1. Preparation of Molar, Normal, ppm and Percent solutions
2. Determination of Osmotic Pressure (OP) of cell sap of given specimen (Rhoeo leaf)
3. Determination of Diffusion Pressure Deficit (DPD) with potato tuber.
4. Comparison of the rate of respiration in germinating seeds and flower buds using simple Respirometer.
5. Rate of photosynthesis under varying CO<sub>2</sub> concentrations in a water plant.
6. Effect of intensity of light on O<sub>2</sub> evolution during photosynthesis using Wilmott's bubble counter.
7. Determination of water absorption/transpiration ratio.
8. Calculation of stomatal index in upper and lower epidermal peelings and the percentage of leaf area
9. Measurement of Respiratory Quotient in germinating seeds.
10. Peroxidase Activity (pH and Temperature)

### **Demonstration Experiments**

1. Nitrification by soil microorganisms.
2. Effect of GA<sub>3</sub> on amylase activity in cereals.
3. Effect of IAA on excised shoot/hypocotyl cuttings of legumes.
4. Demonstration of transpiration rate using simple Potometer

### **b) Bio-Chemistry**

1. **pH** : Measure the pH of cell sap and soil solution.
2. **Buffer**: Preparation of phosphate and sodium citrate buffer.

### **3) Chromatography**

#### **I. Paper Chromatographic technique**

Separation of leaf pigments

Separation of amino acids.

#### **II. Thin layer chromatographic technique**

Separation of leaf pigments

#### **III. Column chromatographic technique to separate chloroplast / Flower pigments.**



#### **4) Qualitative and quantitative methods**

- i) Extraction of plant material-cold percolation
- ii) Qualitative analysis of phytochemicals
- iii) Total free amino acids (Ninhydrin reagent method)
- iv) Proteins ( Lowry *et al.* 1951 method.)
- v) Total soluble carbohydrates (Anthrone method)
- vi) Starch (Clegg's 1956)

#### **Demonstration Experiments**

- 1) Agarose gel Electrophoresis
- 2) Determination of absorption spectra of chlorophyll a and b with spectrophotometer
- 3) Extraction of plant materials using Soxhlet Apparatus

#### **REFERENCES:**

1. **Albert L. Lehninger**, "*Principles of Biochemistry*", CBS Publishers & Distributors, PVT Ltd., New Delhi, 1987.
2. **Frank B. Salisbury** and **Cleon W. Ross**, "*Plant Physiology*", CBS Publishers, New Delhi, 1974.
3. **Geoffrey Zubay**, "*Biochemistry*", Addison Wesley Publishing Company, Sydney, 1984.
4. **Jain, J.L.**, "*Fundamentals of Biochemistry*", S. Chand and Company PVT., LTD., New Delhi, 2002.
5. **Malcom S. Wilkins**, "*Advance Plant Physiology*", Longman Group UK LTD., England, 1987.
6. **Meirion Thomas, S., Ranson** and **Richardson J.A.**, "*Plant Physiology*", Longman group limited, London, 1973,
7. **Robert M. Devlin** and **Francis H. William**, "*Plant Physiology*", CBS Publishers & Distributors, New Delhi, 1972.

## SEMESTER – III

### Core Paper - X

#### BIOINFORMATICS

Instructional Hrs.:75

Sub. Code: I6BOPC310

Max.Marks:CIA 25; ESE -75

Credits:4

**Objectives:** To acquire the skill on computer architecture.

To analyse the structure and sequence of biomolecules using New technology.

#### UNIT- I

15 Hrs.

**Introduction to internet**-Usage of World Wide Web through Internet Explorer - e-mail server - internet server-URL -HTML - HTTP- Scope - Fields related to Bioinformatics- Application of Bioinformatics - *Human genome.*

#### UNIT- II

15 Hrs.

**Molecular biology**- General account of Nucleic acid – structure and chemistry of DNA- RNA- Genes - gene Expression-*Genetic code*- Protein synthesis.

#### UNIT- III

15 Hrs.

**Introduction to Data base** - Biological data bases- Objectives of Biological Databases- Types – Sequence data bases- NCBI – EMBL - DDBJ – SWISS- PROT, PIR-PRF - Structural data bases – PDB - *Carbohydrate database* - Literature databases - Pub Med - Agricola.

#### UNIT -IV

15 Hrs.

**Sequence Analysis**- Sequence alignment - Global and local alignment - Multiple sequence alignment and tools. Phylogenetic analysis - *Construction of phylogenetic tree* and its uses.

#### UNIT -V

15 Hrs.

**Gene finding**- Proteomics (general account) - Protein secondary structure prediction - *Data mining* - Drug designing – *Biomolecular Visualization tools.*

**Note:** **Bold** and *Italics* denote Self Study Topics.

## **Practicals:**

1. Gene prediction using genemark-Algorithm
2. DNA Data Bank
3. Proteins- Secondary structure prediction- Algorithm
4. Literature Database – Pub Med
5. Sequence Alignment

## **REFERENCES:**

1. **Andreas, D., Baxevanis, and B.F., Francis,** “*Ouellette Bioinformatics*”, John Wiley Sons Inc., PVT., LTD., Singapore, 2002.
2. **Arthur M. Lesk.,** “*Introduction to Bioinformatics*”, Oxford University Press, New York, 2003.
3. **Baxevanis and Quellette,** “*A Practical guide to analysis of genes and proteins*”, 1998.
4. **Mani, L. and Vijayaraj,** “*Bioinformatics for beginners*”, Kalai Kathir Achagam, Coimbatore, 2002.
5. **Smart M. Brown,** “*A biologist’s guide to bio computing and the internet*” 2000..
6. **Sundar Rajan, S. and Balaji, R.,** “*Introduction to Bioinformatics*”, Himalaya Publishing House, Mumbai, 2002.
7. **Rajadurai, M.,** “*Bioinformatics*”, PBS Book Enterprises, Chennai, 2010.
8. **Kumaresan, V.** “*Biotechnology*”, Saras publication Revised Edition, 2010.
9. **Shanmugavel, P. & Wadhwa G..** “*Practicals in Bioinformatics*”, Pointer Publishers, Jaipur, India, 2009.

**SEMESTER – III**  
**Skill Based Subject - II**  
**HORTICULTURE**

**Instructional Hrs.: 45**

**Sub. Code:16BOPS302**

**Max.Marks:CIA-25;**

**ESE-75**

**Credits:5**

**Objectives:** To understand the basic aspects of outdoor gardening.  
To know the cultivation methods of vegetables and fruits.  
To enhance the skill in plant propagation methods.

**UNIT- I**

**9 Hrs.**

**Horticulture** -History and importance of Horticulture - *Soil types* – Bio-fertilizers - Methods of plant propagation- layering- cutting – grafting.

**UNIT- II**

**9 Hrs.**

**Outdoor Gardening**- Garden styles- Lawn making- Kitchen garden- Rock garden - Water garden - Floriculture: *cut flower*

**UNIT- III**

**9 Hrs.**

**Indoor gardening** -Terrarium- Bottle and Dish garden- Hanging basket –Hydroponics- Bonsai - flower arrangement- dry decoration-*Ikebana*

**UNIT- IV**

**9 Hrs.**

**Bulb Vegetable**- Onion- Garlic; Tuber Vegetable – Sweet Potato; Root Vegetable – Carrot- Radish- *Beetroot*.

**UNIT -V**

**9 Hrs.**

**Cultivation of fruits** – Banana - Mango- Papaya, Vegetable and fruit carving - *preservation of fruits and vegetables*.

**Note: Bold and Italics denote Self Study Topics**

## REFERENCES:

1. **Aiyar, Yegna Narayana, A.K.** "*Field crops of India*", Bangalore Printing and Publishing Company, Bangalore, 1980.
2. **Sivaranjan, V.V.** and **Indira Balachandra**, "*Ayurvedic drugs and their plant sources*" Oxford-IBH, Bangalore, 1994.
3. **Kumar, N.** Introduction to Horticulture. Oxford IBH Publishing Co. Pvt.Ltd.
4. **Das ,P.C.** Vegetable crops of India, Kalyani publishers, 2003
5. **Prem Singh Arya** . A text book of Vegetable culture, Kalyani publishers, 2002.

## SEMESTER - III

### Skill Based Subject – III

#### GREEN MEDICINE

Instructional Hrs. : 45

Sub. Code : 16BOPS303

Max. Marks : CIA – 25; ESE - 75

Credits : 5

**Objectives :** To acquire the knowledge about the herbal plants.  
To update knowledge on plants used by tribal society.

**UNIT – I** **9 Hrs.**

**Ethnic society of India-** Wild plants and Medicinal Plants used by the Tribal society. Digestive drug- *Cuminum cyminum*-Anti-tumour drug – *Vinca rosea*. Anti- diabetic drug – *Gymnema sylvestre*.

**UNIT – II** **9 Hrs.**

**Carminative drugs-** Cultivation- structure- chemicals and uses – Ginger- Coriander- Asafoetida- Pepper- *Clove* – Garlic.

**UNIT – III** **9 Hrs.**

**Cultivation, chemicals and uses-** *Curcuma longa*- *Foeniculum vulgare*- *Aloe vera* - *Azadirachta indica*.

**UNIT – IV** **9 Hrs.**

**Herbal Cosmetics-** Preparations – Hand lotions- Lipsticks- Skin Fresheners- Face powders - *Sun Screens*.

**UNIT – V** **9 Hrs.**

**Traditional formulations and uses-** *Zizyphus jujuba*- *Syzygium cumini*- *Punica granatum*- *Emblica officinalis*- *Ficus racemosa*.

**Note :** Bold and *Italics* denote Self Study Topics

## REFERENCES:

1. **Gokhale,S.B., Kokate,C.K. and Purohit, A.P.** “*Pharmacognosy*”. Nirali Prakashan, Pune. Sixteenth edition, 2002.
2. **Panda, H.** “*Herbal Cosmetics Handbook*”. Asia Pacific Business Press Inc., New Delhi-35.2008.
3. **Sheelawant Patel.** ‘*Medicinal Trees – Distribution, Characteristics and Traditional Therapeutic Formulations*’.Pointer Publishers, Jaipur. 2009.
4. **Deepak Acharya and Anshu Shrivastava.** “*Indigenous Herbal Medicines Tribal Formulations and Traditional Herbal Practices*”. Aavishkar Publishers,Jaipur.2008.
5. **Rajiv. K. Sinha and Shweta Sinha.** “*Ethnobotany*”. Kalyani Publishers. 2001.
6. **Sivaranjan, V.V. and Indira Balachandra,** “*Ayurvedic drugs and their plant sources*” Oxford - IBH, Bangalore, 1994.

## SEMESTER – IV

### Core Paper - XI

#### GENETIC ENGINEERING AND BIOTECHNOLOGY

**Instructional Hrs.:90**

**Sub. Code:16BOPC411**

**Max.Marks:100**

**CIA25;ESE-75**

**Credits:4**

**Objectives:** To understand the transgenic technology in plants.

To study the microbial production of organic acids and organic manure.

#### UNIT- I

**18 Hrs.**

**Genetic Engineering-** Concepts of genetic engineering – Scope, Molecular Tools for genetic engineering- Cloning vectors (Out line)-Methods of Gene cloning –Polymerase Chain Reaction - *Gene Libraries* - Application of Genetic engineering.

#### UNIT- II

**18 Hrs.**

**Gene transfer methods- *Direct* and *vector mediated*** - Nif- Hup- Nod genes- Transgenic plants— Transgenic plants as Bioreactor- *Human genome project*.

#### UNIT- III

**18 Hrs.**

**Molecular markers and its application-** DNA finger printing- Genetic counselling-Gene therapy-Bone marrow transplantation, methods of gene drug delivery-Vaccine- *Biochips*.

#### UNIT- IV

**18 Hrs.**

**Biotechnology and Environmental Protection:** Biomining – Bioleaching- removal of metals from water- microbial enhancement of oil recovery. Biomass-Types - composition – conversion - *Bio Gas* – BioHydrogen - Petrochemical Plants.

#### UNIT -V

**18 Hrs.**

**Bioremediation & Bio degradation** –Types of Bioremediation- Bio degradation of Xenobiotics – Genetically engineered organisms in bioremediation – Phytoremediation - Global environmental problems and sustainability through Biotechnology - Benefits and ethics of Biotechnology - *Patenting Biotechnology inventions*.

**Note: Bold and Italics denote Self Study Topics.**



## **Practicals**

1. PCR techniques
2. DNA Isolation
3. Biological waste treatment
4. Nitrogen fixing genes
5. Plasmid
6. Transgenic plants
7. Bioleaching

## **REFERENCES:**

1. **Callow, A.J., Ford Lloyd, B.V. and New bury, H.J.**, "*Biotechnology and Plant Genetic Resources Conversation and Use*", CAB international, Oxon, UK.,1997.
2. **Dubey, R.C.**, "*A Text book of Biotechnology*", S. Chand & Company, 1999.
3. **Glazer, A.N. and Nikaid, H.**, "*Microbial Biotechnology*", W.H. Freeman & Company, New York, USA, 1995.
4. **Gupta, P.K.**, "*Elements of Biotechnology*", Rastogi Publication, 1998.
5. **Ignacimuthu, S.**, "*Basic Biotechnology*", Tata Mc Graw Hill Publishing Company Ltd. , Madras, 1985.
6. **Kartha, K.K.**, "*Cryopreservation of plant cells and organs*", CRC Press, Boca Raton, Flora, USA., 1985.
7. **Santharam, S., and Montgomery, J.F.**, "*Biotechnology- Biosafety and Biodiversity*", Oxford and IBH Publishing Co., New Delhi,1999.
8. **Kumar, H.D.**, "*Modern Concepts of Biotechnology*", Vikas publishing house Pvt. Ltd., 2001.

## SEMESTER - IV

### Core Paper - XII

#### ECOLOGY AND CONSERVATION BIOLOGY

**Instructional Hrs.:**75  
**16BOPC412**

**Sub. Code:**

**Max.Marks:** CIA 25; ESE -75

**Credits:**4

**Objectives:** To create Awareness on environmental protection. To study the concept of biotic communities. To conserve biodiversity for future generation.

#### UNIT- I

**15 Hrs.**

**Ecosystem-** Structure and function - Types - Autecology - Population ecology- *Synecology*- Communities - classification - structure.

#### UNIT- II

**15 Hrs.**

**Plant Succession-** Causes of succession - Climax concept - Types of succession – Hydrosere – Xerosere - Biogeochemical cycles - Hydrological cycle - Nitrogen - oxygen – Sulphur – Carbon - *Phosphorus* .

#### UNIT- III

**15 Hrs.**

**Environmental pollution-** Types – Soil – Water – Air - Radiation and Noise Pollution- *Green house effect* - Global warming - Impact of Pollution on vegetation – Ecological indicators.

#### UNIT- IV

**15 Hrs.**

**Natural Resources-** Types – Depletion – Conservation – Sustainable use. Role of Government in Environmental Protection - Awareness Programmes - Ecolabelling- Disaster management and Rehabilitation. Theme Days for Environmental Awareness: World Environmental day, World Wetlands day, World Forestry day, World Water day, *International day for Biological Diversity* .

#### UNIT- V

**15 Hrs.**

**Biodiversity-** Importance – Degeneration – Conservation - *In situ* (Biosphere reserves - National park - Sanctuaries) - *Ex situ* (Zoological and Botanical gardens) - Deforestation and conservation - *Social Forestry*- Man – Wild life conflicts – Causes – Remedial measures.

**Note: Bold and Italics denote self study topics.**

## Practicals

1. Determination of Linear changes in vegetation by using line and belt transect methods.
2. Determination of frequency- density- abundance- dominance index. Similarity Index & Diversity Index by using quadrat frame.
3. Estimation of total biomass and herbage yield by harvest method.
4. Soil and water
  - i) Garden soil experiment to know texture.
  - ii) Capillary water
  - iii) Chemistry of soil ( $\text{NO}_3$ ,  $\text{PO}_4$ ,  $\text{SO}_4$ )
  - iv) pH of the soil
  - v) Water analysis for dissolved oxygen and  $\text{CO}_2$

## REFERENCES:

1. **Ambast, R.S.**, "*A text book of plant ecology.*" Students, Friends & Co., Varanasi, 1988.
2. **Asthana, D.K. and Meera Asthana**, "*A Text book of Environmental studies.*" S. Chand & Co. New Delhi, 2006.
3. **Bhatia, A.L. and Kohli, K.S.**, "*Environmental Biology.*" Ramesh book depot, Jaipur, New Delhi, 2005.
4. **Prabhu,P.C., Udayasoorian, C. and Balasubramanian, G.** "*An Introduction to Ecology and Environmental Science*" Avinash Paperbacks, Delhi, 2009.
5. **Mohan.P.Arora**, Ecology, Himalaya Publishing House, 2006.
6. **Babar,Md.** "*Environmental changes- Natural Disasters*" New India Publishing Agencies, New Delhi, 2007.
7. **Pandey, S.N. and Misra, S.P.** "*Environment and Ecology*, Ane Book Pvt. Ltd., New Delhi, 2011.

## SEMESTER – IV

### Core Paper - XIII

#### RESEARCH METHODOLOGY

**Instructional Hrs.:75**

**Sub. Code: 16BOPC413**

**Max.Marks: CIA 25; ESE -75**

**Credits:4**

**Objectives:** To know the methods and usage of instruments. To study the methods of writing research articles.

#### UNIT -I

**15 Hrs.**

**Lab techniques-** Principles, methodology and uses of Spectroscopy - Infrared, Visible and NMR. Electrophoresis - Agarose gel - *Blotting techniques*-Microscopy -SEM-TEM and Fluorescent - Chromatography - HPLC.

#### UNIT -II

**15 Hrs.**

**Lab techniques-** Extraction – isolation – characterization, identification and quantification of secondary metabolites- Alkaloid- Flavonoids- Terpenoids and *Glycosides*.

#### UNIT- III

**15 Hrs.**

**Biostatistics-** Collection of data – Primary data – Secondary data. Presentation of data - Tabulation graph. Measures of central tendency - *Mean (only arithmetic)*- median and mode. Measures of dispersion – Range - Standard deviation- Standard error. Probability – Theorems of probability. Student's 't' Test. chi-square test - Analysis of variance (ANOVA) - (Theory only).

#### UNIT- IV

**15 Hrs.**

**Research Methodology** - Characteristics of research - Objectives of research - Classification of research - Research Process - Research Problems –and -Criteria for selecting research problem - Steps in selecting research problem – Review of literature – Components and purpose , Journal article – *web Browsing*.

#### UNIT- V

**15 Hrs.**

**Interpretation and Report writing** – Steps in writing report- layout of the report - Types of report - *Mechanics of writing*. Manuscript for publication and proof correction. Citation index, impact factor, h – index and plagiarism.

**Note: Bold and Italics denote Self Study Topics.**

## Practicals

1. Principles and working mechanism of Spectrophotometer, Blotting Techniques, SEM, TEM and HPLC.
2. Problems in Mean, Median, Mode, Standard Deviation, Standard Error, Student 't' test and Chi-square test.

## REFERENCES:

1. **Kothari, C.R.**, *“Research Methodology – Methods and Techniques”*, New Age International Publishers, 2011.
2. **Zar, J.K.**, *“Biostatistical analysis”*, Prentice-Hall International, INC, Englewood cliffs, New Jersey, 1984.
3. **Vijay upagade and Arvind Shende.**, *Research Methodology*, S. Chand & Co., New Delhi, 2010.
4. **Veerakumari, L**, *Bio instrumentation*, MJP Publishers, Chennai, 2009.
5. **Kaur, H.**, *Instrumental methods of chemical analysis*, Pragati Prakashan, Meerut, 2001.
6. **Saravanavel, P.**, *Research Methodology*, Kitav mahal, New Delhi, 2010.
7. **Misra,R.P.**, *Research Methodology- A Hand Book* , Concept Publg Company , New Delhi, 2000.
8. **Rama Krishnan, P**, *“Biostatistics”* Saras Publications, Nagercoil, First Edition, 2001.

**VELLALAR COLLEGE FOR WOMEN (AUTONOMOUS) ERODE-12.**

**M.Sc. DEGREE PRACTICAL EXAMINATIONS**

**Core Practical - III**

**TAXONOMY AND BIOSYSTEMATICS, GENETIC ENGINEERING & BIOTECHNOLOGY  
AND ECOLOGY & CONSERVATION BIOLOGY**

**Hrs: 4**

**Sub. Code: 16BOPCP03**

**Max. Marks: CIA 40;ESE -60**

**Credits:4**

I.	Determine the binomials of <b>A &amp; B</b> with the aid of Gamble's flora.	<b>2 x 5 = 10</b>
II.	Refer the specimens <b>C &amp; D</b> to their respective families giving the salient features indicating their hierarchy.	<b>2 x 4 = 8</b>
III.	Using the vegetative and floral characters construct an artificial Key for the specimens <b>E, F, G, H, I &amp; J</b> . Tabulate the result in a comparison chart.	<b>6</b>
IV.	Give the family and Binomial of <b>K &amp; L</b> .	<b>4</b>
V.	Analysis the vegetation <b>M</b> . Find out the index of dominance.	<b>7</b>
VI.	Write notes of interest on <b>N, O, P, Q &amp; R</b> .	<b>5 x 3 = 15</b>
		-----
		<b>50</b>
	<b>Herbarium</b>	<b>5</b>
	<b>Record</b>	<b>5</b>
		-----
	<b>Total</b>	<b>60</b>
		-----

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**PRACTICAL - III**  
**SCHEME OF VALUATION**

**Time : 4 hrs.**

**Maximum : 60 marks**

I.	A & B	Genus - 2 Species - 1 Family - 1 Authority - 1	<b>2x5 = 10</b>
II.	C & D	Family - 1  Salient features - 3	  <b>2x4 = 8</b>
III.	E, F, G, H, I & J	Key - 3  Comparison chart - 3	  <b>6</b>
IV.	K & L - Herbarium specimen	Family - 1  Binomial - 1	  <b>2x 2 = 4</b>
V.	M - Quadrat	Data - 5  Comment - 2	  <b>7</b>
VI.	N - Economic Botany O - Economic Botany P - Biosystematics Q - Genetic Engineering R - Ecology		     <b>5 x3 = 15</b>
			----- <b>50</b>
		<b>Herbarium</b>	<b>5</b>
		<b>Record</b>	<b>5</b>
			-----
		<b>Total</b>	<b>60</b>
			-----

# M.Sc. DEGREE PRACTICAL EXAMINATIONS

## Core Practical - IV

### PLANT PHYSIOLOGY & PHYTOCHEMISTRY, BIOINFORMATICS AND RESEARCH METHODOLOGY

Hrs: 4

Sub. Code: 16BOPCP04

Max. Marks: CIA 40;ESE -60

Credits: 4

- I. Write the procedure and requirements for the experiments **A & B** assigned to you by lot. Perform the experiments, Collect the necessary data and present your conclusion. Leave the setup for valuation. 2 x 10 = 20
- II. Comment on the setup **C & D**. 2 x 4 = 8
- III. Write down the algorithm for the given practical of **E**. 7
- IV. Workout the given problem **F**. 7
- IV. Write notes of interest on **G & H**. 2 x 4 = 8

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	<b>50</b>
Record	<b>10</b>
	-----
Total	<b>60</b>
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**PRACTICAL - IV**  
**SCHEME OF VALUATION**

**Time : 4 hrs.**

**Maximum : 60 marks**

I.	A	- Plant physiology		
	B	- Phytochemistry	Set up	- 3
			Procedure	- 3
			Data & Result	- 4
				<b>2 x 10= 20</b>
II.	C	- Plant physiology		
	D	- Phytochemistry		<b>2 x 4 = 8</b>
III.	E	- Algorithm in Bioinformatics		
		(Gene finding/Protein prediction)		<b>7</b>
IV.	F	- Biostatistics (Chi square/ students 't' test/ theorems of probability)		<b>7</b>
V	G	- Bioinformatics - DNA Data bank / Sequence alignment / Literature database		
	H	- Research Methodology- SEM/TEM/Blotting techniques		<b>2x4= 8</b>

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**50**

Record **10**

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Total **60**

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**PG & RESEARCH DEPARTMENT OF BOTANY**

**M. Sc. BOTANY**

**Question Paper Pattern**

**CORE PAPERS**

**Duration: 3 hrs**

**Marks: 75**

**Section – A**

**(10 × 1 = 10 marks)**

Multiple Choice Questions – 10 (Two from each unit)

(Q. No 1 – 10)

**Section – B**

**(5 × 5 = 25 marks)**

Answer all the Questions (Either or pattern)

Two Question from each unit

(Q. No 11 – 15)

**Section – C**

**(5 × 8 = 40 marks)**

Answer all the Questions (Either or pattern)

Two Question from each unit

(Q. No 16-20)

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**NON MAJOR ELECTIVE**

**Five Questions out of Eight**

**(5 × 15 = 75 marks)**

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**SKILL BASED SUBJECTS**

Paper I - Online Examination 60 Marks, Internal evaluation 40 marks=100 marks

Paper II & III - Five Questions out of Eight) (5 × 15 = 75 marks)

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**SELF LEARNING PAPERS**

**Five Questions out of Eight  
marks)**

**(5 × 20 = 100**

## **SELF LEARNING PAPER I**

### **WEALTH FROM WASTES**

**Sub. Code: 13BOPSL02**

**Max.Marks: 100**

**Credits: 5**

#### **Objectives:**

Gaining momentum in the millennium by utilizing the available wastes and channel them towards economic activities.

#### **UNIT- I**

**Organic wastes-** Compost making – Different methods, sources of Biogas generation (Animal, Human, Agriculture, Aquatic & Industrial wastes).

#### **UNIT -II**

**Biomedical wastes** - Sources, types, Disposal methods, segregation, Recycling – composting, Incineration.

#### **UNIT- III**

**Coir wastes in Agriculture** - Coir waste compost – Composition, Coir waste briquetting, application of briquetting. Coir waste in Poultry and Crop Production, Coir waste as mulch and rooting medium.

#### **UNIT- IV**

**Agricultural wastes** - Paper manufacturing – Kinds of agricultural wastes, operations in paper and paper board making. Sugarcane wastes – Pressmud – Bioearth, Sugarcane trash composting, creating art objects, Mushroom cultivation.

#### **UNIT- V**

**Sewage water** - Utilization of sewage water, sewage treatment, Treatment of Effluent – Paper mill, Distillery, Vermi Composting.

## REFERENCES:

1. **Asthana, D.K. and Meera Asthana**, "*Environment Problems and Solutions*", S.Chand and Company Ltd. First Edition, 2002.
2. **Dubey, R.C.**, "*A text book of Biotechnology*", S. Chand and Company, 2001.
3. **Kumaresan, V.**, "*Biotechnology*", Saras Publication, Chennai, 2005.
4. **Narayana Rao, M. and Amal K. Dutta**, "*Waste water treatment*", Oxford IBH Publishing Co. Pvt. Ltd. New Delhi, second edition, 2003.
5. **Palaniappan, S.P. and K. Annadurai**, "*Organic farming theory and practice*", Scientific Publications, Jodhpur, India. 2003.
6. **Sakharkar, B.M.**, "*Principles of Hospital Administration and Planning*", First Edition, Published by Jaype Brothers, 2003.
7. **Sathe, T.V.**, "*Vermiculture and Organic farming*", Daya Publishing house, New Delhi, 2004.