SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

BOTANY – CURRICULUM

M.Sc. General (Semester Pattern)

M. Sc. FIRST YEAR
BOTANY

JUNE, 2014

BOTANY – CURRICULUM

M.Sc. General (Semester Pattern)

CURRICULUM DESIGNING COMMITTEE

1.	**Dr.Bodke S.S.** Yeshwant Mahavidyalaya, Nanded	Chairman
2.	**Dr. Kadam A.S.** D.S.M. Mahavidyalaya, Jintur	Member
3.	**Dr. Mandge S.V**. Shri. SGM College, Loha	Member
4.	**Dr. Gawai D.U.** Science College, Nanded	Member
5.	**Dr. Dakore H.G.** P.N.College, Nanded	Member
6.	**Dr. Aithal S.V**. Vai. D.M.Mahavidyalaya, Degloor	Member
7.	**Dr. Biradar S.D.** D.S.M.College, Parbhani	Member
8.	**Dr. Bhadraiah B.** Osmania University, Hyderbad	Member
9.	**Dr. Patil D.A.** SSVP's Dr. Ghogre Science College, Dhule	Member
10.	**Dr. Mukadam D.S.** Green Gold seeds Ltd., Walunj	Member
11.	**Dr. Gacche R.N.** SRTM University, Nanded	Member

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M. Sc. FIRST YEAR BOTANY CURRICULUM - An Outline:

Class	Paper No.	Title of Paper	Periods/ Practicals	Exam. Time Duration	Marks
M.Sc. Botany, First year Semester-I (Theory)	Theory Paper-I	Biology and Diversity of Microbes	45	3 Hrs.	50
	Theory Paper-II	Biology and Diversity of Cryptogams	45	3 Hrs.	50
	Theory Paper-III	Diversity of Seed Plants and Their Systematics	45	3 Hrs.	50
	Theory Paper-IV	Plant Structure and Developmental Biology	45	3 Hrs.	50
M.Sc. Botany, First year Semester-I (Practical)	Practical Paper-I	Based on Theory Paper-I	10+04	6 Hrs.	50
	Practical Paper-II	Based on Theory Paper-II	10+04		
	Practical Paper-III	Based on Theory Paper-III	10+04	6 Hrs.	50
	Practical Paper-IV	Based on Theory Paper-IV	10+04		
M.Sc. Botany, First year Semester-II (Theory)	Theory Paper-V	Instrumentation and Methods In Biology	45	3 Hrs.	50
	Theory Paper-VI	Cell Biology, Genetics and Plant Breeding	45	3 Hrs.	50
	Theory Paper-VII	Plant Ecology, Environmental Biology and Phytogeography	45	3 Hrs.	50
	Theory Paper-VIII	Plant Resource Utilization and Conservation	45	3 Hrs.	50
M.Sc. Botany, First year Semester-II (Practical)	Practical Paper-V	Based on Theory Paper-V	10+04	6 Hrs.	50
	Practical Paper-VI	Based on Theory Paper-VI	10+04		
	Practical Paper-VII	Based on Theory Paper-VII	10+04	6 Hrs.	50
	Practical Paper-VIII	Based on Theory Paper-VIII	10+04		

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THEORY PAPER – I: BIOLOGY AND DIVERSITY OF MICROBES

Periods – 45 Marks – 50

UNIT –I: VIRUSES, BACTERIA AND MYCOPLASMA (12 Periods)

Viruses: General characters**,** chemical composition, Ultra structure of plant viruses (TMV), Virus multiplication, transmission of plant viruses, Symptoms of viral diseases of plants and Economic importance of viruses. **Bacteria:** General characters, Ultra Structure, Nutrition (Autotrophic, Heterotrophic and Symbiotic), Reproduction (Binary fission, Transformation, Transduction and Conjugation), Symptoms of Bacterial diseases of plants, Economic importance of Bacteria. **Mycoplasma:** General characters, Ultra structure, Symptoms of Mycoplasma diseases of plants, Economic importance of Mycoplasma.

UNIT – II: MYCOLOGY-I (10 Periods)

Fungi: General characters, Classification (As per Ainsworth, 1973; Alexopoulos and Mims, 1979), Ultra structure of fungal cell, Thallus organization, Nutrition **(**Saprotrophs, Biotrophs, Necrotrophs, Symbiotrophs) and reproduction (Asexual and Sexual). **Fungal Cytology and Genetics:** Heterothallism, Heterokaryosis, Parasexuality, Physiological specialization of pathogenic races.

UNIT – III: MYCOLOGY-II (10 Periods)

A comparative account of vegetative and **reproductive structures,** Life cycle patterns and Phylogeny of different fungal groups- Gymnomycota, Mastigomycota and Amastigomycota: Zygomycotina, Ascomycotina, Basidiomycotina and Deteuromycotina

UNIT – IV: APPLIED MYCOLOGY (13 Periods)

Fungi as food and feeds: Mushrooms – Types, cultivation, nutritional and medicinal value, Role of fungi in food processing. **Fungi in industry:** Production of alcohol, medicine, organic acids and enzymes. **Fungi in agriculture and forestry:** Role of fungi in humus formation, formation of mycorrhizal association with plants; Role of fungi in biological control of pests. **Fungi as bio fertilizers:** Mycorrhizae (Ecto and endo). **Fungi in destruction of articles in daily use:** Wood destruction, spoilage of house hold articles, **Lichens:** General characters, types and economic Importance.

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PRACTICAL PAPER – I: BASED ON THEORY PAPER - I

Practicals – 14 Marks – 50

Practical Exercises:

1. Preparation of Stains (Cotton blue, Lactophenol, Gram's iodine, Crystal violet, Safranine, light green).
2. Preparation of Culture media (PDA /Czapek Dox Agar/ Nutrient Agar.)
3. Staining of bacteria by simple and Gram's staining method.
4. Isolation and identification of fungi from Air.
5. Isolation and identification of fungi from Soil by dilution plate technique.
6. Effect of carbon sources on spore germination of fungi by hanging drop technique.
7. Effect of nitrogen sources on growth of fungi by colony diameter method.
8. Study of fungi: *Stemonitis, Agaricus, Polyporus, Ganoderma, Morchella, Geastrum, Lycoperdon.*
9. Determination of alcohol produced by Yeast (*Saccharomyces cerevisiae*)
10. Estimation of Citric acid produced by *Aspergillus niger*.
11. Determination of antibiotics produced by *Penicillium* sp.
12. Study of symptoms and causal organism of bacterial plant diseases: Citrus canker, Black arm of Cotton, Leaf spot of Mango.
13. Study of symptoms and causal organism of plant diseases caused by Viruses: Yellow vein mosaic of Bhendi, Leaf curl of Tomato, Bean mosaic, Papaya mosaic.
14. Study of symptoms and causal organism of plant diseases caused by Mycoplasma: Little Leaf of Brinjal, Sesamum phyllody and Grassy shoot of Sugar cane.
15. Study of lichens
16. At least one long botanical excursion, several local excursions and visits to Industries, Research institutes, Agriculture universities etc.

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THEORY PAPER – II: BIOLOGY AND DIVERSITY OF CRYPTOGAMS

Periods – 45 Marks – 50

Unit-I: ALGAE-I (12 Periods)
Introduction: Algal habitats, Thallus organization, evolutionary trends and classification of algae as per F.E. Fritsch (1944) and G.M. Smith (1955). Criteria used in algal classification (Pigments, reserve food materials), flagella, cell wall, ultra cell structure, algal blooms, Reproduction (vegetative, asexual and sexual) and Economic importance

Unit II: ALGAE-II (10 Periods)
Study of algal groups: Chlorophyta, Euglenophyta, Pyrrophyta, Chrysophyta, Phaeophyta, Cyanophyta and Rhodophyta (General characters, Morphology and life history are expected).
Unit III: BRYOPHYTA (10 Periods)
Introduction: Habitat, Habit, distribution and outline of classification of Bryophytes as per Smith (1955) and Proskauer (1957). **Study of Morphology, anatomy and reproductive structures:** Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales, Structure and evolution of gametophytes and sporophytes in Bryophytes.

Unit IV: PTERIDOPHYTA AND PALAEOBOTANY (13 Periods)
Pteridophyta: General characters and classification (based on the classification proposed by Smith, 1955; Bold, 1957 and Zimmermann, 1959). Comparative account of morphology and anatomy of gametophyte and sporophytes in Psilotales, Lycopodiales, Equisetales, Filicales and Marsileales. Stelar evolution in Pteridophytes; Heterospory and its biological advantages; Origin of seed habit and Economic importance of Pteridophytes .
Palaeobotany: Principles of palaeobotany, importance of fossil plants, General account of Lepidodendrales, Calamitales and Sphenophylalas.

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PRACTICAL PAPER – II: BASED ON THEORY PAPER -II

Practicals – 14 Marks – 50

Practical Exercises:

1. Collection and preservation of Algae, Bryophytes and Pteridophytes.
2. Isolation of algae from soil and water
3. Description, Identification, and classification of the algae- Chroococcus, *Oscillatoria, Scytonema*
4. Identification, classification and description, of the algae- *Volvox, Hydrodictyon, Pediastrum*
5. Identification, classification and description, of the algae- *Nitella, Laminaria, Sargassum*
6. Identification, classification and description, of the algae- *Fucus*, *Porphyra*, *Polysiphonia*
7. Study of External and Internal Structure of *Marchantia, Pellia*.
8. Study of External and Internal Structure of *Anthoceros, Notothylus*.
9. Study of External and Internal Structure of *Sphagnum*, *Polytrichum*.
10. Study of Morphology, Internal Structure (Double stained slide preparation) and reproductive Structures of *Psilotum, Lycopodium*
11. Study of Morphology, Internal Structure (Double stained slide preparation) and reproductive Structures of *Selaginella, Equisetum, Marsilea*
12. Study of Morphology, Internal Structure (Double stained slide preparation) and reproductive Structures of *Ophioglossum* and *Pteris*
13. Study of fossils- *Lepidodendron* and *Calamities*
14. At least one long and several local Botanical excursions

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THEORY PAPER – III: DIVERSITY OF SEED PLANTS AND THEIR SYSTEMATICS

Periods – 45 Marks – 50

Unit-I: GYMNOSPERMS (10Periods)
General characters and classification Gymnosperms as proposed by Professor Birbal Sahni (1920), Sporne (1965), S.P. Bhatnagar and Alok Moitra (1996). Comparative account of sporophyte and gametophyte of Cycadales, Ginkgoales, Coniferales and Gnetales. General account of Pteridospermales, Pentoxylales and Cordiatales. Economic importance of Gymnosperms

Unit-II: GENERAL PRINCIPLES OF TAXONOMY (10Periods)
Principles of taxonomy as applied to the systematic, taxonomic structure, Biosystematics, Floristic and Plant geography. Origin and evolution of Angiosperms. Concept of species- Morphological, Taxonomical, Biological. Categories of classification and rules regarding their nomenclature. ICBN-Principles, rules and recommendations. Biological nomenclature, theories of biological classification, structural, biochemical and molecular systematics, numerical taxonomy.

Unit-III: TAXONOMIC EVIDENCES, TOOLS AND BIOSYSTEMATICS (13Periods)
Taxonomic evidences and techniques used in-Morphology, micro morphology and palynology. **Taxonomic tools**- Herbarium, floras, botanical gardens, use of keys in plant identification, computers, GPS and GIS. Biosystematics- steps in bio system, biosystematics, category and importance of bio systematic studies

Unit-IV: PLANT SYSTEMATICS (12Periods)
Comparative account of various systems of classification of angiosperms proposed by Linnaeus, Bentham and Hooker, Engler and Prantl, Hutcinson. Comparative account of following Angiospermic families- Magnoliaceae, Ranunculaceae, Brassicaceae, Rosaceae, Fabaceae, Euphorbiaceae, Malvaceae, Dipterocarpaceae, Apiaceae, Asclepiadaceae, Verbenaceae, Solanaceae, Rubiaceae, Cucurbitaceae, Asteraceae, Poaceae, Liliaceae, Orchidaceae.

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PRACTICAL PAPER – III: BASED ON THEORY PAPER -III

Practicals – 14 Marks – 50

Practical Exercises:

1. Study of Morphology, Internal Structure (Double stained Slide Preparation) and Reproductive Structure of *Thuja* and *Ephedra*.
2. Study of Morphology, Internal Structure (Double stained Slide Preparation) and Reproductive Structure of *Araucaria* and *Ginkgo*.
3. Study of Morphology, Internal Structure (Double stained Slide Preparation) and Reproductive Structure of *Taxus* and *Gnetum*.
4. Study of Fossil Gymnosperms with the help of Slides / Specimens
5. Description and identification of at least three plant species belonging to different families of order – Ranales with their floral formulae and floral diagrams
6. Description and identification of at least three plant species belonging to different families of order Geraniales with their floral formulae and floral diagrams
7. Description and identification of at least three plant species belonging to different families of order Myrtales with their floral formulae and floral diagrams
8. Description and identification of at least three plant species belonging to different families of order Centrospermae with their floral formulae and floral diagrams
9. Description and identification of at least three plant species belonging to different families of order Rubiales with their floral formulae and floral diagrams
10. Description and identification of at least three plant species belonging to different families of order Tubiflorae with their floral formulae and floral diagrams
11. Description and identification of at least three plant species belonging to different families of order Scitaminae with their floral formulae and floral diagrams
12. Description and identification of at least three plant species belonging to different families of order Glumiflorae with their floral formulae and floral diagrams
13. Field trips within and around the campus
14. At least one Botanical excursion, compilation of field notes and preparation of wild and cultivated plants as are abundant

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THEORY PAPER – IV: PLANT STRUCTURE AND DEVELOPMENTAL BIOLOGY

Periods – 45 Marks – 50

Unit I: ROOT AND SHOOT DEVELOPMENT (12 Periods)
Introduction, importance and scope of histology and anatomy of plants. Organization of root apical meristem (RAM), Vascular tissue differentiation, Lateral root and root hairs. organization of shoot apical meristem (SAM). Types of vegetative shoot apex. Cytological and molecular aspects of SAM. Vascular tissue differentiation- Xylem and phloem. Wood development in relation to environmental factors. Significance of study of three dimensional structure of wood

Unit II: LEAF AND FLORAL DEVELOPMENT (10 Periods)
Development, types and phyllotaxy of leaf, Leaf structure with reference to C3 and C4 plants, Kranz anatomy and CAM syndrome, Structure and types of stomata and trichomes.
Floral meristem and floral development in Arabidopsis and Antirrhinum, Vascular anatomy of flower, Inferior ovary, transition to flowering, Role of floral anatomy in taxonomy

Unit III: CONCEPT OF PLANT DEVELOPMENT (13)
Potency, Commitments, specification, induction competence determination and differentiation, morphogenetic gradients, cell fate and celllineages, stem cell, genomic equivalence and cytoplasmic determinants, imprinting mutants and transgenic in the analysis of development. Development of male and female gametophytes, pollination, fertilization, development and function of endosperm, Patterns of embryo development, Polyembryony and apomixes, experimental embryology, pollen storage and fertilization.

Unit IV: PALYNOLOGY (10)
Palynology- Importance and scope of palynology, Application of palynology in oil exploration and forensic science. Pollen morphology, **Palynotaxonomy-** Role of palynology in taxonomy, **Palaeopalynology-** Principles, microfossil groups, **Aeropalynology-** Principles, techniques of pollen analysis, pollen calendar its importance, spore allergy, allergic properties of pollen, **Agropalynology-** pollen viability, pollen germination, pollen storage and their significance.

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PRACTICAL PAPER – IV: BASED ON THEORY PAPER -IV

Practicals – 14 Marks – 50

Practical Exercises:

1. Study of root and shoot apical meristems with the help of permanent slides.
2. Study of epidermal peels for stomatal types / stomatal index
3. Study of trichomes
4. Study of secretary tissues with the help of permanent slides
5. Study of Xylem elements by maceration technique
6. Preparation and staining of slides for the study of floral anatomy by microtome technique.
7. Microscopic examination of Pollengrains by Chitale technique.
8. Pollen viability test by using tetrazolium salts
9. Pollen germination test hanging drop / sitting drop cultures,/ suspension culture or surface culture.
10. Study of monosporic, bisporic and teltrasporic types of embryo sac development through examination of permanent stained serial sections.
11. Study of nuclear cellular endosperm through dissections and staining.
12. Field study of several types of flower with different pollination mechanisms (wind pollination, Bat pollination, bee/butterfly pollination, bird pollination).
13. Preparation of shortlist of ten important firewood and timber wood in the locality (With local names, scientific names, families and their properties).
14. Preparing an inventory of the bamboos and ratoons in the locality (with scientific and local names and various uses with illustrations).
15. Students must attend at least one long and one short botanical excursion arranged by the department and they must a detail report on plant diversity at the time of practical examination.

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SELECTED READINGS

SEMESTER – I
BOTANY, PAPER-I

1.	Vashishta B.R. (1990)	Botany for Degree Students Part-I Algae	S. Chand & Co. New Delhi.
2.	Vashishta B.R. (1990)	Botany for Degree Students Part-II Fungi	S. Chand & Co. New Delhi.
3.	Alexopolous C.J. & C.W. Mims (1979)	Introductory Mycology	Wiley Eastern Ltd., New Delhi
4.	Smith G.M. (1971)	Cryptogamic Botany Vol-I. Algae and Fungi	Tata McGraw Hill Publishing Co. New Delhi.
5	Dubey H.C. (1990)	An Introduction to Fungi	Vikas Publishing House, New Delhi.
6	Sharma P.D. (1995)	The Fungi	Rastogi & Co., Meerut.
7	Sharma O.P. (1992)	A Text Book of Thallophytes	Tata McGraw Hill Publishing Co. New Delhi.
8	Fritsch F.E.(1945)	The Structure and Reproduction of Algae Vol-I & II.	Cambridge University Press.
9	Chapman V.J. and D.J. Chapman (1962)	The Algae, English Language Book Society	McMillan, London.
10	Mehrotra R.S. and K.R.Aneja (1990)	Introduction to Mycology	Wiley Eastern Ltd. New Delhi.
11	Pandey S.N.,P.S. Trivedi and S.P. Mishra ( )	A Text Book of Botany Vol-I & II	Vikas Publishing House, New Delhi.
12	Pandey B.P. (2000)	College Botany Vol-I (Algae, Fungi, Bryophytes)	S. Chand & Co. New Delhi.
13	Pandey B.P. (2000)	College Botany Vol-II (Pteridophyta, Gymnosperms, Paleobotany)	S. Chand & Co. New Delhi.
14	Clintion A (1958)	Introduction to Bacteria	McMillan, New York.
15	Bower F.O. (1988)	Primitive Land Plants Vol-I & II	Arihant Publishers, Jaipur.
16	Gangule H.C. & Kar A.K. (1995)	College Botany Vol-II	New Central Book Agency, Calcutta.
17	Rajan S. Sundra (1995)	College Botany Vol-I & II	Himalaya Publication House.
18	Saxena A.K.& Sarabhai R.P. (1968)	Text Book of Botany Vol-I	Ratan Prakashan Mandir, Agra.
19	Saxena A.K. & Sarabhai R.P. (1968)	Text Book of Botany Vol-II	Ratan Prakashan Mandir, Agra.
20	Bodke S.S. and N.M.Dhekle (2007)	Diversity of Microbes and Cryptogams	Mansi Prakashan, Nanded

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BOTANY, PAPER-II

1	Smith G.M. (1971)	Cryptogamic Botany Vol-II Bryophytes and Ptridophytes	Tata McGraw Hill Publishing Co. New Delhi.
2	Sharma O.P. (1992)	A Text Book of Pteridophytes	Tata McGraw Hill Publishing Co. New Delhi.
3	Vashishta B.R. (1990)	Botany for Degree Students Part-III Bryophyta	S. Chand & Co. New Delhi.
4	Puri P. (1980)	Bryophyta	Atmaram & Sons. New Delhi.
5	Parihar N.S. (1965)	An Introduction to Embryophyta Vol-I Bryophyta	Central Book Depot, Allahabad.
6	Vashishta P.C. (1991)	Botany for Degree Students Part-V Vascular Cryptogams (Pteridophyta)	S. Chand & Co. New Delhi.
7	Parihar N.S. (1965)	An Introduction to Embryophyta Vol-II Pteridophyta	Central Book Depot, Allahabad.
8	Sharma O.P. (1992)	A Text Book of Pteridophytes	McMillan (India) Ltd
9	Rashid A (1976)	An Introduction to Pteridophyta	Vikas Publishing House, New Delhi
10	Sporne K.R. (1976)	The Morphology of Pteridophytes	B.I. Publication, Bombay
11.	Pandey B.P.	Text book of Botany Gymnosperms	S. Chand & Co. Ltd. New Delhi.
12.	Biswas C. B. M. Johri	The Gymnosperms	Narosa Publishing House, New Delhi.
13	Bodke S.S. and N.M.Dhekle (2009)	Cryptogamic Botany	Sanket Prakashan, Nanded

BOTANY, PAPER-III

1. Davis P. H. and Heywood V.H. (1993) – Principles of Angiosperms Taxonomy Tobert E. Kreigher Pub. Co. New York

2. Grant. V. (1971) – Plant Speciation – Columbia University Press New York.

3. Harrison, H.J. (1971) – New concepts in flowering plant Taxonomy – Hieman Educational Books Ltd. London

4. Heslop – Harrison J. (1967) – Plant Taxonomy- English Language Book Soc. and Edward Arnold Pub. Ltd. UK.

5. Hey wood. V.H. and Moore D.M. (1984) – Current concepts in plant Taxonomy, - Academic press, London.

6. Jones A.D. and Wilbins, A.D. (1971) – Variation and adaptations in plant species. Hieman & Co-Educational Books Ltd. London.

7. Jones S.B. Jr. and Luchsinger, A.E. (1986) – Plant systmatics (2nd edition) Mc Graw Hill Book Co., New York.

8. Nordenstam, B.EL Gazaly, G. and Kassas, M. Zooo – Plant systematic for 21st Century. Portland press Ltd. London.

9. Radford, A.E. (1986) – Fundamentals of plant systematics – Harper & Row Publications, USA.

10. Stebbins G.L. (1974) – Flowering plant Evolution Above species level – Edward Arnold Ltd., London.

7. Plant Taxonomy and Bio Systematics (2nd, edition) – Edward Arnold Ltd. London

8. Takhtajan A.L. (1997) Diversity and classification of flowering plant – Colubia University, press New York.

13. Woodland, D.W. (1991) – Contemporary plant systematics : Pentice Hall, New Jersey.

14. Flora of Osmanabad – V. N. Naik.

15. Flora of Marathwada – Chief Ed. By Dr. V.N. Naik.

16. Bodke S.S. and N.M.Dhekle (2013): Key to selected Angiospermic plants, Kusha Publisher & Distributer, Nanded

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BOTANY, PAPER-IV

1.	Tayal M.S. (1983	Plant anatomy	Rastogi Publication, Meerut.
2.	Pandey B.P. (1993)	Plant anatomy	S. Chand & Co. Pvt. Ltd.
3.	Saxena A.K., & R.P.Sarabhai (1975)	Atext book of Botany Vol – II Embryophyta	Kitab Ghar, Gwaliar Pergamon Press Oxford.
4.	Singh v, Pande P.C. D.K. Jain (1994)	Anatomy of seed plants.	Rstogi Publication, Meerut.
5.	Esau K (1977)	Anatomy of seed plants	John Wiley & Sons, New York
6.	Eames A.J. & L.H. MacDaniel (1974)	Introduction to plant anatomy	Mc Graw Hill Book Co. New York.
7.	Maheswari P. (1972)	An introduction to embryology of Angiosperms	Tata Mc Graw Hill Pub. Co. Ltd. New York.
8.	Bhojwani S.S. Bhatnagar S.P.(1974)	Embryology of Angiosperms Angiosperms.	Vikas Publication House Pvt. Ltd. New Delhi.
9.	Dwivedi J.N. (2000)	Embryology of Angiosperms	
10.	Bodke S.S. and N.M.Dhekle (2009):	Anatomy, Embryology & Ecology	Sanket Prakashan, Nanded

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THEORY PAPER – V: INSTRUMENTATION AND METHODS IN BIOLOGY

Periods – 45 Marks – 50

Unit-I: INSTRUMENTATION-I (13 Periods)

Safety in laboratory - Safe use of laboratory equipments, Personal protection,Hazards and waste disposal. **Microscopy –** Working and application of simple microscope, compound microscope, Dark field microscope, phase contrast microscope, fluorescence microscope, scanning and transmission electron microscope, cytophotometry and flow cytometry, Micrometry ,fixation and staining, **Sterilization methods**.(Autoclave, Hot air oven and Filtration).

Unit-II: INSTRUMENTATION-II (12 Periods)

Principles , working and applications of Laminar air flow, pH Meter, Colorimeter and Spectrophotometer (visible and UV), Paper chromatography,Principles and application of gel filtration, Ion exchange and affinity chromatography, Column chromatography, TLC and Gas chromatography, HPLC, HPTLC, Electrophoresis & Electrofocussing, Ultracentrifugation (velocity & buoyant density).

Unit-III: METHODS IN BIOLOGY-I (10 Periods)

Biophysical Methods: Principle and method of X-ray diffraction, UV visible, fluorescence, NMR and ESR spectroscopy and ORD / CD visible. **Hydrodynamic Methods:** Atomic absorption and plasma emission spectroscopy. Principles and **Application of tracer technique:** Radiation dosimetry, radioactive isotopes and half life of isotopes, autoradiography, effect of radiations on biological systems

Unit-IV: METHODS IN BIOLOGY-II (10 Periods)

Histochemical and Immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, Western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, in-situ localization by techniques- FISH and GISH. **Molecular Biology Methods:** Analysis of RNA, DNA and proteins by one and two diamensional gel electrophoresis, isolation, separation and analysis of carbohydrate and lipid molecules, RFLP, RAPD and AFLP techniques.

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PRACTICAL PAPER – V: BASED ON THEORY PAPER –V

Practicals – 14 Marks – 50

Practical Exercises:

1. Rules and regulations for safety in laboratory.
2. Study the principle and working of compound microscope.
3. Sterilization of Media/Glassware with the help of autoclave and hot air oven.
4. Calibration of Microscope and measurement of microorganisms.
5. Study the principle and working of pH meter and measurement of pH of soil / solutions.
6. Study the principle and working of colorimeter, Spectrophotometer and centrifuge.
7. Separation of amino acids by paper chromatography or paper electrophoresis
8. Separation of chlorophyll pigments by thin layer chromatography.
9. Detection of plant proteins by Polyacrylamide Gel Electrophoresis.
10. Detection of molecules using ELISA
11. Analysis of DNA and RNA by one and two dimensional gel electrophoresis,
12. Isolation, separation and analysis of carbohydrate molecules from plant material.
13. Isolation, separation and analysis of lipid molecules from plant material.
14. Effect of radiations on biological systems (Seed germination)
15. Visit to research centre (CCMB, NCL, CFTRI, ICRISAT, and BARC), Biotechnology/ Tissue culture laboratories, Agriculture Universities, Pharmaceutical industries etc.

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THEORY PAPER – VI: CELL BIOLOGY, GENETICS AND PLANT BREEDING

Periods – 45 Marks – 50

Unit-I: CELL BIOLOGY-I (13 Periods)

Structure and function of prokaryotic and eukaryotic cells, Structural organization and function of Cell wall, Mitochondria, Vacuoles, Chloroplast. **Chromosome-** structure and function; Heterochromatin, Euchromatin. **Cell division and cell cycle-** Mitosis, Meiosis and their regulation steps in cell cycle, regulation and control of cell cycle. Structure and function of cytoskeleton. **Membrane structure and function-** lipid bilayer and membrane protein. Cell signalling and cell receptors, G-Protein Coupled Receptor, signal transduction.

Unit-II: GENETICS-I (12 Periods)

Crossing over- Types, mechanism of meiotic crossing over, significance of crossing over. Linkage map or genetic mapping: linkage groups, map distance, gene order, interference and coincidence, chromosome: physical or cytological mapping, Characters of multiple alleles; examples: A, B, AB and O blood groups in humans, Rh factor, **Linkage –** Types of linkage, deletion of linkage, Sex linked inheritance, sex determination and molecular basis of sex differentiation

Unit-III: GENETICS-II (10 Periods)

Gene structure and regulation of gene expression, Extra chromosomal inheritance (Episomes, Mitochondria and Chloroplasts), Transposons, Karyotype. **Mutation –** types of mutation, reverse mutation, application of mutation. Chromosomal aberrations- deletions, duplication, inversion, translocation, variation in chromosome morphology. Dose Compensation, **Population genetics**: Hardy- Weinberg law : genetic equilibrium; application of Hardy- Weinberg law in calculating gene frequencies in a population

Unit-IV: PLANT BREEDING (10 Periods)

Genetic analysis in plant breeding: Concepts of a population and gene pool, concepts of population genetics: Quantitative traits and Polygenes and polygenic inheritance; **Tools in plant breeding**: Sexual hybridization and wide crosses, Tissue culture and the breeding of clonally propagated plants, Mutagenesis, Polyploidy, Biotechnology, Issues in the application of biotechnology in plant breeding

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PRACTICAL PAPER – VI: BASED ON THEORY PAPER –VI

Practicals – 14 Marks – 50

Practical Exercises:

1. Study of different stages of mitosis and determination of mitotic index in *Allium/ Aloe/ Chlorophytum/Pea*
2. Study of mitotic abnormalities in *Allium* cells by chemical treatments.
3. Study of different stages of meiosis and meiotic irregularities in *Allium* and *Rhoeo/ Tradeschantia*
4. Isolation of Mitochondria from eukaryotic cell
5. Isolation of Chloroplasts from plant cell
6. Study of ultramicroscopic structures of cell organelles with the help of Photographs (Golgi apparatus, Ribosomes,Chloroplast,Mitochondria E.R. and Nucleus,)
7. Study of mutation in Yeast/Bacteria by replica plate technique.
8. Study of Karyotype and ideogram in plants/ human
9. Determination of blood grouping
10. Problems based on Multiple alleles.
11. Problems based on Gene mapping
12. Problems based on linkage
13. Problems based on Hardy Weinberg equation
14. Visit to research institutes / Biotechnology/ Tissue culture laboratories / Agriculture Universities

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THEORY PAPER – VII: PLANT ECOLOGY, ENVIRONMENTAL BIOLOGY AND PHYTOGEOGRAPHY

Periods – 45 Marks – 50

Unit-I: ECOLOGY (12 Periods)
Introduction- Scope and importance of ecology in India, Ecological tools and techniques, Sampling techniques of population, methods of estimating primary production and consumer production. **Ecosystems -** Concepts of ecosystem, ecological factors, structure of ecosystem. **Function of Ecosystem** - Energy flow and mineral cycling (C, N, P), Primary production and decomposition, **Structure and function of some Indian ecosystems –** Terrestrial ecosystem (Grassland and Forest ecosystem), Aquatic ecosystem (Fresh water, marine and estuarine ecosystem), Food chain, Food web and ecological pyramids

Unit-II: POPULATION ECOLOGY (10 Periods)
Characterization of a population, population growth curves, population regulation, life history strategies (Y and K selection), **Concepts of metapopulation-** demes and dispersal, interdemic extinctions, age structured populations. **Community ecology-** Nature of communities, community structure, levels of species diversity and its measurement, edges and ecotones. **Ecological succession –** Types, mechanism, changes involved in succession, concept of climax.

Unit-III: ENVIRONMENT AL BIOLOGY(13 Periods)
The Environment – Physical and biotic environment, biotic and abiotic interactions. **Environmental pollution –** Causes, effects and control measures of air, water, soil and thermal pollution, Nuclear hazards, phytoremediation, Global warming and climate change, acid rains, ozone layer, ozone hole. **Social issues and the environment –** EPA 1986, Urban problems related to energy, water conservation, rain water harvesting, environmental ethics, issues and possible solutions.

Unit-IV: PHYTOGEOGRAPHY (10 Periods)
Introduction, concept, phytogeographical regions of India, Ecological importance of forests, aforestation, deforestation, social forestry, Endemism, endemic and endangered species of India, IUCN categories, Red data books, Biodiversity and its conservation, Protected area network, convention on biological diversity, concept of sustainable development.

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PRACTICAL PAPER – VII: BASED ON THEORY PAPER –VII

Practicals – 14 Marks – 50

Practical Exercises:

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use test for comparing two means related ecological data.
2. To find out the relationship between two ecological variables using correlation and regression analysis.
3. To study the vegetation by Line Transect method
4. To determine minimum size and number of quadrates required for reliable estimate of biomass in grassland.
5. To determine **IVI** of the species in grass land using suitable method & state whether vegetation is homogeneous or heterogeneous.
6. To determine gross and net phytoplankton productivity by light & dark bottle method.
7. To determine the soil carbonates by rapid titration method.
8. To find out association between important grassland species using Chi-square test.
9. To determine the water holding capacity of soils collected from different locations.
10. To determine percent organic carbon and organic matter in the soils of cropland, grassland & forest
11. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by Winkler's method.
12. To determine the biochemical oxygen demand (BOD) of polluted water.
13. To estimate chlorophyll content in SO_2 fumigation and unfumigated plants leaves.
14. Scientific visits to Biosphere reserves, National park, Sanctuary, Mangrove vegetation, NBPGR New Delhi or its regional circles, Head quarters of BSI or its regional circles, CSIR labs doing research on plant utilization, ICAR research station or field station, Recognized botanical garden / museum (FRI Dehradun, NBRI – Lucknow. Tropical botanical garden and research institute Trivendrum)

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THEORY PAPER – VIII: PLANT RESOURCE UTILIZATION AND CONSERVATION

Periods – 45 Marks – 50

Unit-I: PLANT RESOURCE DEVELOPMENT – I (12 Periods)
Domestification and introduction of plants, origin of cultivated plants, plants as source of food, fodder, fibre, spices, beverages, edible oils, drugs, narcotics, insecticides, timber, gums, resins, dyes, latex, cellulose, starch, and its products. Importance of ethno botany in Indian context. Botanical gardens and herbaria

Unit-II: PLANTS AND CIVILIZATION (13 Periods)
Centres of origin and gene diversity, Vavilov's centers of origin, Botany, utilization, cultivation of plants and improvement of food, drugs, fiber and their industrial values, unexploited plants of potential economic values, plants as source of renewable energy, genetic resources and their conservation, tissue culture in plant propagation and enrichment of genetic diversity, role of biotechnology in agriculture, medicine, industry and green house technology. The structure of plant based industries in Maharashtra, the present scenario and future prospectus.

Unit-III: CONSERVATION-I (10 Periods)
Green revolution- Benefits and adverse consequences, Principles of conservation, major approaches to conservation and current practices in conservation of genetic diversity, species diversity, ecosystem diversity. **Conservation strategies –** In-situ conservation, Indian case studies on conservation strategies- project tiger, biosphere reserves, sanctuaries, National parks, Mangroves, on-farm and home garden conservation.

Unit-IV: CONSERVATION-II (10 Periods)
Conservation strategies – Ex-situ conservation, principles and practices, germ plasm collections, Botanic gardens, seed banks, test tube gene banks, pollen banks, cryobanks, ex-situ conservation of microbes Social approaches to conservation- sacred groves, sthalavrikshas peoples movement for biodiversity conservation- Chipko movement, Chipko river dam and tribal campaign. Role of universities and other educational institutions in biodiversity conservation. Role of BSI, NBPGR, ICAR, CSIR and Department of Biotechnology in sustainable development.

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PRACTICAL PAPER – VIII: BASED ON THEORY PAPER –VIII

Practicals – 14 Marks – 50

Practical Exercises:

1. Study of important food, fodder plants.
2. Study of important vegetable, fruits, spices and oil yielding plants.
3. Micro chemical tests for food materials form cereals, pulses, oils/fats, spices.
4. Study of morphology, anatomy, microscopic study of whole fibre using appropriate stain of textile fibres (cotton, jute) cordage fibre (coir)
5. To estimate the reducing and non-reducing sugars from different fruit juices and food materials.
6. Study of some important medicinal plants (Neem, Adhatoda, Ocimum, Garlic Aloe,)
7. Study of some important medicinal plants (Mentha, Withania, Asparagus, Brahmi)
8. Performing simple tests for gums, resins, dyes, and to understand their chemical nature in water.
9. Performing simple test for Narcotics, insecticides, & beverages.
10. To estimate Iodine number of fats.
11. To estimate protein from food materials by suitable method.
12. To estimate carbohydrates from food materials by suitable method.
13. Case studies on conservation strategies in India.
14. Scientific visits to Biosphere reserves, National parks, Sanctuary, A mangrove forests, NBPGR New Delhi or its regional circles, Head quarters of BSI or one of its regional circles.
15. Scientific visits to CSIR laboratories, doing research on plant utilization, ICAR research station or field station, Recognized botanical garden/museum (FRI Dehradun, NBRI-Lucknow, Tropical botanical garden and research institute Trivendrum).

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SELECTED READINGS

M. Sc. FIRST YEAR
SEMESTER – II
BOTANY, PAPER-V

Sr. No.	Name of Book	Name of Author	Publisher
1.	Biophysical Chemistry.	M. Sataske, Y. Hayashi, M.S. Sethi, S A Iqbal,	Discovery Publishing House (1997) New Delhi – 110002.
2	Practical Microbiology.	R. C. Dubey, D K Maheshwari	S Chand and company Ltd. New Delhi
3	Instrumental Methods of Chemical Analysis 5th Ed.	Galen W Ewing.	Mc Graw Hill International
4	Biotechniques Theory and Practice	S Y S Rana	Rastogi Publications, Meerat 250002
5	A manual of laboratory experiments in cell biology	C Edward Gasque	Universal book Stall, New Delhi.
6	Plant tissue culture	Kalyan Kumar DC	New Central Book Agency (P) Ltd. Calcutta 700009.
7	Modern experimental biochemistry 3rd ed.	Rodney Boyer	Pearson education Inc.
8	Research Experiences in plant physiology.-A Laboratary Mannual	Thomas C. Moore	Spinger-Verlag,Berlin.
9	Biochemical methods 2nd ed.	S. Sadasivam, A. Manickam.	New Age International Publisher (P) Ltd, New Delhi.
10	Experiments in Microbiology, Plant Pathology and Tissue Culture	K.R. Aneja,	Wishwa Prakashan, New Delhi.
11	Applied Microbiology	Vinita Kale, Kishore Bhusari	Himalaya publishing Hourse, Mumbai.
12	An Introduction to Microbiology	P. Tauro, K.K. Kapoor, K S Yadav	Wiley Eastrevn Limited, New Delhi.
13	Frontiers in Applied Microbiology	K.G. Mukerji, N C Pathak, Vedpal Sing	Print Hall, Lucknow
14	Practical Microscopy	Martin and Johnsen	Blackie and Sen Limited, London
15	Microbial Genetics	Stanley R Maloy, John E. Cronan David Freitelder	Narosa Publishing House, New Delhi.
16	Industrial Microbiology	Richard W Thomas	Dowden, Hutchinson & Ross Inc. Stroudtiury Penasytuna.

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Sr.	Name of Book	Name of Author	Publisher
1.	Molecular Biology of Gene	J.D. Watson T.A. Baker S.P. Bell Alexander Gann Michael Levine Richard Losick	Pearson Education Singapore, Pvt.Ltd. Indiam Branch 482 FIE Patporganj Delhi 110 092.
2.	Genes – Vol. V, VI & VII	Benjamin Lewin	Oxfor University Press New York.
3.	Basic Human Genetics	Elaine Johansen Mange & Arthur Mange	Rastogi Publication. Shivaji Raod, Meerut.
4.	Principles of Genetics	E.J. Gardner, M.J. Simmons D.P. Snastad	John Willy and Sons Ansari Road, Daryaganj. New Delhi. 110 002.
5.	Genetics Vol. I & II	C.B. Powar	Himalaya Publication New Delhi.
6.	Gentics	B.D. Singh	Kalyani Publishers B-1/1292, Rajander Nagar, Ludhiana – 141 008.
7.	Genetics	P.K. Gupta	Rastogi Publication, Shivaji Raoad, Meerut – 250 002.
8.	Genetics Analysis & Principles	Robert J. Brooker	Addison Wesley Longman Inc. New York.
9.	Molecular Genetics	Gunther S. Stent Richard Calendar DaryaGanj,	CBS Publishers Distributors – 4596/1-A New Delhi. – 110 002.
10.	Text Book of Molecular Biology	K.Sivarama Sastry G. Padmanaban C. Subramanayam	MacMillan India Ltd. Delhi.
11.	Cell Biology, Genetics, Molecular Biology, Evolution and Ecology	P.S. Verma V.K. Agarwal	S. Chand Publisher New Delhi.
12.	Cytology Genetics & Evolution.	P.K. Gupta	Rastogi Publication, Meerut.
13.	Cell Structure and Function	Ariel. G. Loewy Philip Siekevit2	Oxford & IBH Publishing Cor. Pvt. Ltd., Delhi.
14.	Cell Physiology	Arthur Giese	W.B. Saunderies Company, London.
15.	Cell Biology	E.J. Ambrose Dorothy M.Easty	Vikas Publication, Bombay.
16.	Introduction to Cell Biology	S.Sundara Rajan Pvt. Ltd. Delhi.	Vikas Publishing House
17.	Cell Biology	C. B. Powar	Himalaya Publishing House. Delhi
18.	Cell Biology	Johnson Lewys	Sarup & Sons New Delhi. – 110 002.
19.	Genetic Engineering	Sandhya Mitra	Mac. Millan India, Ltd. New Delhi
20.	Cytology	P.S. Verma	S.Chand

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		V.K. Agarwal	New Delhi.
21.	The Living Cell	Donald Kennedy	W.H. Freeman and Company, Sanfrancisco.
22.	The Science of Genetics	William Hexter H.T. Yost	Prentics-Hall of India India Pvt. Ltd. New Delhi
23.	Studies on Genetics	H.J. Muller	Oxford & IBH Publisher New Delhi.
24.	Genetics	A.M. Winchester	Oxford & IBH Publisher New Delhi.
25.	Genetics	B. guttman, a. Griffiths d. Suzuki t. Cullis.	Oxford Publisher England, London
26.	Fundamentals of Genetics	M.P. Arora	Himalaya Publishing House. Delhi.
27.	The Biology of Cells	Herbert Sterm David L. Nanney	Willey Eastern Pvt. Ltd. New Delhi
28.	Genetic Engineering & its Application.	P. Joshi	Agrobios India Ltd.
29.	Cell and Molecular Biology	S.C. Rastogi	New Age International Publisher. New Delhi.
30.	Cell Biology, Fundamentals and Applications	M.L. Gupta M.L. Jangir	Student Edition India Ltd. , Jodhpur.

BOTANY, PAPER-VII

	Title of the Book	Name of the Author	Name of the Publisher
1.	An Introduction to Environemntal Pollution	Sharma B.K. Kaur H.	Goel Publishing House, Meerut. (1996)
2.	Environemntal Biology	Biswarup Mukherjee	Tata MC Graw Hill Publishing House, New Delhi. (1996)
3.	Environemntal Science & Biotechnology	A.G. Murugesan	MJP Publishers, Chennai. (2005)
4.	Theory & Techniques	C. Rajakumari	
5.	Environemntal Science Systems & Solutions	Michael L. Mc Kinney Robert M. Schoch	Jones & Bastlett Publishers, London. (1996)
6.	Environemntal Biology (Principles of Ecology)	P.S. Warma A.K. Agrawal	S. Chand & Co. Ramnager (1993)
7.	Biological Control of Environemntal Pollution	P. Kumar	Sarup & Sons, New Delhi. (2002)
8.	Practical Methods in Ecology and Environmental Science	R.K. Trivedy P.K. Goel C.L. Trisal	Environemntal Publications, Karad. (1987)
9.	The Ecdogy of Insect Population in Theery and Practice	L.R. Clark P.W. Geier R.D. Hughes R.F. Morris	The English Language Book Society and Chapman & Hall.
10.	Environmental Pollution Analysis	S.M. Khopkar	New Age International (P) Ltd., Pubshers. (2001)
11.	Environmental Biology	H.R. Singh	S.Chand & Company Ltd. (2005)
12.	Environmental Ecology &	V. Kumaresan	Saras Publication.

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	Pollution	N. Arumugum	(1997)
13.	Methods in Environmental Analysis, water soil & air	P.K. Gupta	Agrobios (India). (2000)
14.	Environmental Impact of Chemicals. Assessment & Contol	Michael D. Quint David Taylor & Rupert Rurchase	The Royal Society of Chemistry.
15.	The Chemical Industry Friend to the Environment	J.A. G. Drake	Royal Society of Chemistry.
16.	Preshistroic Man and his Environment	W. Raymond wood R. Bruce Mc Millan	Academic Press, New yark.
17.	Recent Advances in Environment Science	K.G. Hiremath	Discovery Publishing House, New Delhi. (2003)
18.	Biodiversity and Sustainable Utilization of Biological Resurces	T. R. Sahu	Scientic Publishers, Jodhpur. (2004)
19.	Environmental Biotechnology	Geetha Bai Ramamurthi Rallapalli S.B. Sullia Aziz Shiralipour Satish kastury	A.P.H. Publishing Corporation. (2002)
20.	Food Nutrition & Environmental Security The road Ahead	`	National Institute of Science Communication, N. Delhi.
21.	Environmental Pollution	Timmy Katyal M. Satake	Anmol Publications, Pvt. Ltd. (1996)
22.	Fondamental Ecology	Arthur S. Boughey	Intext Educatinal Publishers. (1971)
23.	A Test book of Environmental Science	R.N. Trivedi	Anmol Publications, Pvt. Ltd. (1993)
24.	Environmental and Plant Ecology	John R. Etherington	Wiley Eastern Ltd. (1975)
25.	Noise Pollution	Debi Prasad Tripathy	A.P.H. Publishing Corporation. (1998)
26.	Environmental Pollution	Laurent Hodges	HOLT, Rinehart & Winston. Inc. (1973)
27.	Plants and Environment	R.F. Daubenmir	John Wiley & Sons, Inc New York. Chapman & Hall Ltd. London. (1947).
28.	Pollution Biology	Leslie Read	Academic Press, Inc. (1983).
29.	A Text Book of Energy Ecology Environment & Society	A. Moheshwari Geeta Parmar	Anmol Publication, Pvt. Ltd. (2002)
30	India's Environment Crises and Responces	J. Bandyopathyay N. D. Jayal U. Schoetlli Chhatrapatising	Natraj Publication, Rajpur Road, Dehradun. (1985)
31.	Air Pollution Physiological Effects	James J. McGrath Charles D. Barnes	Academic Press, New Yark, Landon. (1987)
32.	Photochemistry Of Air Pollution	Philip A. Leighton	Academic Press, New Yark, Landon. (1961)
33.	Air Pollution (Third Edition Vol. II)	Arthur C. Stern	Academic Press, New Yark, Landon. (1977)
34.	Biodiversity Consevation	Kotwal Bonerjee	Argobios, (India) 2000.
35.	Biodiversity	Ramamurthi Rallapalli	APH Housing Corporation,

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		Geetha Bai	New Delhi. (2002)
36.	Concepts of Ecology	Edward J. Kormondy	Perntice Hall of India Pvt Ltd. (1974)
37.	Current Pollution Researches in India	R.K. Trivedy P.K. Goel	Environmental Publications, Karad. (1985)
38.	Molecular Approaches to Ecology	Marcel Florkin and Ernest schoffeniels	Academic press, New Yark. (1969)
39.	Fundamentals of Ecology	Eugene P. odum	Natraj Publishers, Dehra Dun. (1996)
40.	Environmental Studies	H. Kaur	Pragatiprakashan. (2005)
41.	Elements of Ecology	P. D. Sharma	Rastogi Publications.
42.	Elements of Ecology	George L. Clarke	Johnwiley & sons, Inc. New Year, London. (1954)
43.	Ecology & nvironment	P.D. Sharma	Rastogi Publications. (1996)
44.	Environmental Science	S.C. Santra	New Central Book Agency, Pvt. Ltd. (2005)
45.	Respectives in Environment	Dr. S.K. Agarwal J.P. Kaushik K.K. Koul A.K. Jain	A.P.H. Housing Carporation, New Delhi. (1998)
46.	Environmental Awareness	Dr. D.N. Khairnar	Vision Publications.
47.	Environmental Pollution	Timmy Katyal M. Satake	Anmol Publications, Pvt. Ltd. (1998)
48.	Air Pollution & Plant Life	Michael Treshow	John Wiley & Sons .(1984)
49.	An advanced text Book on Biodivessity	K.V. Krishnamurthy	Oxford & IBH Publishing, Co. Pvt. Ltd. (2006)
50.	Environmental & development	Asish Ghosh	A.P.H. Publishig Corporation, New Delhi. (2000)
51.	Environment Management with Indian Experience	Dlip Roy	A.P.H. Publishig Corporation, New Delhi. (1998)
52.	Environment Globalchanges and challenges	Ram Prakash	ABD Publishers, Jaipur. (2003)
53.	Pollution Control For Agriculture	Raymond C. Loehr	Academic Press. Inc. (1984).
54.	Man and his Environment		John Murray Albern Marle Street, Landon.
55.	Environmental Problems	P.R. Trivedi Gurdeep Raj	Akashdeep Publishing House, New Delhi. (1997)
56.	Environmental Biology	K.C. Agarwal	Agro Botanica. (1999)
57.	Environmental Challenges	C.K Varshney D.R. Sardesai	Wiley Eastiern Ltd. (1993)
58.	Environmental Impact Assessment & Management	B.B. Hosetti A. Kumar	Daya Publishing House. (1998)
59.	An Introduction to Plant Ecology	A.G. Tanshley	Discovery Publishing House. (2003)
60.	Environmental Impact Assessment	S.A. Abbass D.S. Arya	Discovery Publishing House. (2000)
61.	Plant Ecology	P.L. Kochhar	Ratan Prakaranmandir. (1994)
62.	Introduction to Plant Ecology	Maurice Ashby	Macmillan & English Language Book Society.
63.	Plant Ecology & Phytogeoraphy	V. Kumaresan	Saras Publications. (2001)
64.	Weed Ecology	Steven R. Radosevich Jodies Hott	John Willey & sons. (1984)
65.	Animal Ecology	P.S. Verma	S.Chand & Company Ltd.

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		V.K. Agarwal	(1992)
66.	Ecology & Environment	P.D. Sharma	Rastogi Publication.
67.	Consepts of Ecology	N.Arumugam	Saras Publications. (2003)
68.	ATB of Environmental Studies	Erach Bharucha for University Grants Connission	University Press, (India) Pvt. Ltd. Hyd. (2005)
69.	Environmental Biology (Principles of Ecology)	P.S. Varma V.K. Agarwal	S.Chand & Co. Ltd. N. Delhi. (2005)
70.	Ecology (Environmental Biology)	V.K. Agarwal Usha Gupta	S.Chand & Co. Ltd. N. Delhi. (2004)
71.	An Advanced Text Book on Biodiversity (Prihciples & Practice)	K.V. Krishna Murthy	Oxford & IBH Publishing, Co. Ltd. N. Delhi.
72.	Bodke S.S. and N.M.Dhekle (2009): Anatomy, Embryology & Ecology Sanket Prakashan, Nanded		

BOTANY, PAPER-VIII

	Title of the Book	Name of the Author	Name of the Publisher
01	India's Environment Crises and Responces	J. Bandyopathyay N. D. Jayal U. Schoetlli Chhatrapatising	Natraj Publication, Rajpur Road, Dehradun. (1985)
02	Air Pollution Physiological Effects	James J. McGrath Charles D. Barnes	Academic Press, New Yark, Landon. (1987)
03.	Photochemistry Of Air Pollution	Philip A. Leighton	Academic Press, New Yark, Landon. (1961)
04	Air Pollution (Third Edition Vol. II)	Arthur C. Stern	Academic Press, New Yark, Landon. (1977)
05.	Biodiversity Consevation	Kotwal Bonerjee	Argobios, (India) 2000.
06.	Biodiversity	Ramamurthi Rallapalli Geetha Bai	APH Housing Corporation, New Delhi. (2002)
07.	Concepts of Ecology	Edward J. Kormondy	Perntice Hall of India Pvt Ltd. (1974)
08.	Current Pollution Researches in India	R.K. Trivedy P.K. Goel	Environmental Publications, Karad. (1985)
09.	Molecular Approaches to Ecology	Marcel Florkin and Ernest schoffeniels	Academic press, New Yark. (1969)
10.	Fundamentals of Ecology	Eugene P. odum	Natraj Publishers, Dehra Dun. (1996)
11.	Environmental Studies	H. Kaur	Pragatiprakashan. (2005)
12.	Elements of Ecology	P. D. Sharma	Rastogi Publications.
13.	Elements of Ecology	George L. Clarke	Johnwiley & sons, Inc. New Year, London. (1954)
14.	Ecology & nvironment	P.D. Sharma	Rastogi Publications. (1996)
15.	Environmental Science	S.C. Santra	New Central Book Agency, Pvt. Ltd. (2005)
16.	Respectives in Environment	Dr. S.K. Agarwal J.P. Kaushik K.K. Koul A.K. Jain	A.P.H. Housing Carporation, New Delhi. (1998)
17.	Environmental Awareness	Dr. D.N. Khairnar	Vision Publications.
18.	Environmental Pollution	Timmy Katyal M. Satake	Anmol Publications, Pvt. Ltd. (1998)
19.	Air Pollution & Plant Life	Michael Treshow	John Wiley & Sons .(1984)
20.	An advanced text Book on	K.V. Krishnamurthy	Oxford & IBH Publishing,

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	Biodivessity		Co. Pvt. Ltd. (2006)
21.	Environmental & development	Asish Ghosh	A.P.H. Publishig Corporation, New Delhi. (2000)
22.	Environment Management with Indian Experience	Dlip Roy	A.P.H. Publishig Corporation, New Delhi. (1998)
23.	Environment Globalchanges and challenges	Ram Prakash	ABD Publishers, Jaipur. (2003)
24.	Pollution Control For Agriculture	Raymond C. Loehr	Academic Press. Inc. (1984).
25.	Man and his Environment		John Murray Albern Marle Street, Landon.