BERHAMPUR UNIVERSITY

COURSES OF STUDIES

FOR

THE M.Sc. BOTANY EXAMINATIONS

(SEMESTER SYSTEM)

1st and 2nd Semester Examination – 2013, 2014

3rd and 4th Semester Examination – 2014, 2015

Published by:

BERHAMPUR UNIVERSITY

BHANJA BIHAR

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The Post-Graduate (M.Sc.) curricula in Botany is of two-year duration with total of 1600 marks. The system of examination is of semester pattern. There will be four semesters consisting of four theory papers for First, Second and Third semester and two theory papers for the Fourth Semester. There will be two practical papers in each semester (First to Third) and one practical in the Fourth semester. There will be two special papers and the student has to opt for any one special paper of his/her choice. In addition, students have to carry out a project work in the Fourth semester. Each theory paper carries an internal assessment of 20% of the total marks. Each theory and practical examinations will be of three hours duration exception for the practical in Fourth semester, which will be of six hours duration. The project work carries 50 marks, 30 for the dissertation and 20 for the seminar presentation. The student has to present article/ paper in departmental seminar. The students will be assessed once in the second semester and once in the fourth semester. The student should secure at-least 50% in the seminar paper in order to pass the semester examination. The seminar presentation of the student will be evaluated by 2/3 staff members of the department as per availability on the seminar dates.

SEMESTER	Marks Theory	Marks Internal Assessment	Marks Seminar presentation / Field study / Scientific visit/ Field survey	Marks Practical/ Dissertation	Total Marks
First	60 x 4	15 x 4		50 x 2	400
Second	60 x 4	15 x 4	50	50 x 2	450
Third	60 x 4	15 x 4		50 x 2	400
Fourth	60 x 2	15 x 2	50	100 x 1	
			50	100(dissertation)	350
Grand Total:					1600

Semester wise breakdown of Marks, Semester system

First Semester:	**Theory**	**Internal Assessment (Theory)**	**Seminar**	**Practical**	**Total**
1.1	60	15			
1.2	60	15			
1.3	60	15			
1.4	60	15			400
1.5				50	
1.6				50	
Second Semester:					
2.1	60	15			
2.2	60	15			
2.3	60	15			
2.4	60	15			
2.5				50	
2.6				50	
2.7			50		450

(Two minimum seminars per student per year and one seminar per semester. The seminar will be purely internal to be evaluated by faculty members of the dept.)

Third Semester:					
3.1	60	15			
3.2	60	15			
3.3	60	15			
3.4	60	15			
3.5				50	
3.6				50	400

Fourth Semester: There will be two special papers; the student has to opt for one.

4.1	60	15			
4.2	60	15			
(Elective Papers)					
4.3				100	
Seminar 4.4			50		
Field study/ 4.5			50		
Scientific visit/					350
Field survey.					
Dissertation 4.6				100	
				T o t a l	**1600**

(The department staff council will decide whether they will opt for 4.3 or 4.6 in a particular batch for a particular year as per availability of staff / resources / funds etc.). Papers- 2.7 of second semester; 4.4 & 4.5 of 4th semester will be purely internal to be assessed by department faculty members.

[Each student will deliver two seminar presentations per year and at-least one seminar per semester. The total seminar marks will be evaluated by the department staff members and will be purely internal. The student has to submit a detailed field study / scientific visit / filed survey report through the guide/ supervisor. This paper will be evaluated by the department staff members.

DETAILED SEMESTER WISE SYLLABUS
FIRST SEMESTER EXAMINATION

THEORY PAPER
Paper – 1.1: Plant diversity I: Microbiology, Phycology, Mycology and Pathology
Paper – 1.2: Plant diversity II: Bryophyta, Pteridophyta, Gymnosperms and Paleobotany
Paper – 1.3: Cell biology & Evolution
Paper – 1.4: Ecology
PRACTICAL PAPER:
Paper – 1.5: Based on Theory Paper 1.1 & 1.2
Paper – 1.6: Based on Theory Paper 1.3 & 1.4

SECOND SEMESTER EXAMINATION

THEORY PAPER
Paper – 2.1: Molecular Biology and Genetics
Paper – 2.2: Adv. Plant Physiology & Metabolism
Paper – 2.3: Adv. Plant Biochemistry and Biostatistics
Paper – 2.4: Environmental Pollution & Management
PRACTICAL PAPER:
Paper – 2.5: Based on Theory Paper 2.1 & 2.2
Paper – 2.6: Based on Theory Paper 2.3 & 2.4
Paper – 2.7: Seminar presentation

THIRD SEMESTER EXAMINATION

THEORY PAPER
Paper –3.1: Systematics of Angiosperms & Economic Botany
Paper – 3.2: Natural Resources, Conservation and Utilization
Paper – 3.3: Plant Embryology and plant anatomy
Paper – 3.4: Plant Biotechnology and Tissue culture
PRACTICAL PAPER:
Paper – 3.5: Based on Theory Paper 3.1 & 3.2
Paper – 3.6: Based on Theory Paper 3.3 & 3.4

FOURTH SEMESTER EXAMINATION

THEORY PAPER (Special paper—Elective –to be opted by the student)
Paper – 4.1: Environmental Biotechnology / Microbiology
Paper – 4.2: Environmental Management / Microbial technology
PRACTICAL PAPER:
Paper – 4.3: Based on Theory Paper 4.1 & 4.2
Paper – 4.4: Seminar presentation
Paper – 4.5 Field study/ scientific visit/ Field survey
Paper – 4.6 DISSERTATION in lieu of 4.3 [Project work (Dissertation & Presentation)]

(The department staff council will decide whether they will opt for 4.3 or 4.6 in a particular batch for a particular year as per availability of staff / resources / funds etc.). Papers- 2.7 of second semester; 4.4 & 4.5 of 4th semester will be purely internal to be assessed by department faculty members.

[Each student will deliver two seminar presentations per year and at-least one seminar per semester. The total seminar marks will be evaluated by the department staff members and will be purely internal. The student has to submit a detailed field study / scientific visit / filed survey report through the guide/ supervisor. This paper will be evaluated by the department staff members and will be purely internal.}

The student has to carry out a project work under the guidance of any one of the faculty members on a topic on botany, plant sciences or environmental biology. The student has to present the project work in the departmental seminar which is to be evaluated (out of 50 marks) by the board of examiners consisting of the faculty members (Internal). Subsequently the student has to submit the

dissertation just after theory examination for evaluation (out of 50 marks) by the examiners [One external (external of the practical examination) and respective supervisors as internal, the mean marks secured by the candidate is to be considered, which will be decided by the Head by simple calculation of external + internal marks divided by 2]

FIRST SEMESTER

PAPER – I.1

PLANT DIVERSITY I: MICROBIOLOGY, PHYCOLOGY, MYCOLOGY AND PATHOLOGY

MICROBIOLOGY:

Bacteria and Archaea: Classification, cell structure, nutrition, growth, reproduction, Economic importance. Bacterial genetics: plasmid and episome, conjugation, transduction and transformation.

Phytoplasma: General characteristics and role in causing plant diseases.

Cyanobacteria: Classification, cell structure, nutrition, reproduction, cellular differentiation, heterocyst and its function. Economic importance of cyanobacteria,

Virus: General properties, structure, purification, cultivation, principle of viral taxonomy, classification, one step growth experiment and lifecycle, Economic importance of virus. Viriods and Prions.

PHYCOLOGY:

Algae: distribution (terrestrial, freshwater, marine); thallus organization; cell structure; criteria for classification of algae; pigments, reserve food, flagella, reproduction (vegetative, asexual, sexual). Salient features of Chlorophyta, Euglenophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Economic importance of algae. Algal blooms and toxins, algae as biofertilizer, food, feed, and uses in industry.

MYCOLOGY & PATHOLOGY:

General characters of fungi; substrate relationship in fungi; cell ultra-structure, unicellular and multicellular organization; nutrition (saprobic, biotrophic, symbiotic) reproduction (vegetative, asexual, sexual); heterothallism; heterokaryosis; parasexuality; recent trends in classification. Phylogeny of fungi. General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina. Fungi in industry, medicine and food; fungal diseases in plants and its control, Fungi as biocontrol agent,. Mycorrhizae, Lichen.

Select text books for reading:

Alexopoulus, C. J., Mims, C. W. and Blackwel, M. (1996). Introductory Mycology, John Wiley, New York.

Kumar, H. D. (1988). Introductory Phycology. East-West Press, New Delhi.

Maloy, S. R., Cronan, J. E. Jr. and Freifielder, D. (2008). Microbial Genetics, 2nd Ed. Norosa, New Delhi.

Mehrotra, R. S. and Aneja, R. S. (1998). An Introduction to Mycology, New Age International, New Delhi.

Prescott, L. M., Harley, J. P. and Klen, D. A. (1999). Microbiology, 4th Ed. WCB-McGra-Hill, New Delhi.

PAPER – I.2

PLANT DIVERSITY II: BRYOPHYTA, PTERIDOPHYTA, GYMNOSPERMS AND PALEOBOTANY

BRYOPHYTA:

Morphology, structure, reproduction and life history. Distribution, classification, general account of Marchantiales, Jungermaniales, Anthoceratales, Sphagnales, Funariales and Polytrichales. Ecological importance.

PTERIDOPHYTA:
Morphology, anatomy and reproduction; classification; evolution of stele; heterospory and origin of seed habit. General account of Psilopsida, Lycopsida; Sphenopsida and Pteropsida.
GYMNOSPERMS:
General characteristic feature of Gymnosperms, Classification of Gymnosperms and their distribution in India. General account of Cycadales, Coniferales, Ephedrales, and Gnetales.
PALEOBOTANY:
Geological time scale, origin and geological evidences; evolutionary time scale (eras, periods and epoch). Types of fossils, processes of fossilization, role of fossils in evolution. Brief account of fossil Pteridophytes and Gymnosperms. Cycadeoidales, Pentoxylales, Medullosales and Glosspteriodales.

Select text books for reading:
Maloy, S. R., Cronan, J. E. Jr. and Freifielder, D. (2008). Microbial Genetics, 2nd Ed. Norosa, New Delhi.
Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
Parihar, N. S. (1991). Bryophyta. Central Book Depot, Allahabad.
Parihar, N. S. (1991). Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
Chamberlin, C. J. (1935). Gymnosperms: Structure and Evolution. Dover Publications, New York.

PAPER – I.3
CELL BIOLOGY & EVOLUTION

Structural organization and function of intracellular organelles:
Structural organization of the plant cell, structure and functions of cell wall, plasma membrane; ion carriers, channels and pumps; receptors. Chloroplast, mitochondria, peroxisome, endoplasmic reticulum, ribosome, lysosome, vacuole, nuclear pore and nucleolus. Cell shape and motility: cytoskeleton, organization and role of microtubules and microfilaments, implications in flagellar and other movements.
Cell division, cell cycle and cell signaling:
Cell cycle: mitosis, meiosis, DNA synthesis in cell cycle, regulation of cell cycle: role of cyclins and cyclin-dependent kinases; cytokinesis and cell plate formation; cell surface receptors, G-protein coupled receptors, signal transduction pathways, secondary messengers, regulation of signalling pathways.
Structure and organisation of eukaryotic chromosomes:
Chromatin and chromosome, heterochromatin and euchromatin, special types of chromosomes, karyotype, chromosome banding, sex chromosomes, sex determination in plants, dosage compensation, B-chromosomes, Packing of DNA, Nucleosome. Nuclear DNA content, C-value paradox, satellite DNA, cot-curve, unique and repetitive DNA.
Evolution: Theories and evidences of organic evolution, Lamarckism; Darwinism-concepts of variation, adaptation, struggle, fitness and natural selection. .The evolutionary synthesis, Origin of basic biological molecules, concept of Oparin and Haldane, experiments of Miller (1953), the first cell, Evolution of prokaryotes, Origin of eukaryotic cells, Gene pool, Gene frequency; Hardy-Weinberg Law, Isolating mechanisms- speciation, Convergent evolution, sexual selection, Co-evolution, Origin of new genes and proteins; molecular evolution and polymorphism; Molecular tools in phylogeny.

Select text books for reading:

Buchachnanan, B. B., Grissem, W. and Jones, R. L. J., (2000). Biochemistry and molecular biology of plants. American Society of plant physiologists, Rockville, USA
Cooper G. M. (1997). The Cell: A molecular approach. ASM Press, Washington, D. C., USA.
Malacinski, G. M and Feidfelder, D (1998). Essentials of Molecular Biology, 3rd Ed. Jones and Bartel, London.
Lewine, B. (2004) Gene VIII, Person-Prentice Hall, London.

PAPER – I.4 (ECOLOGY)

Scope of Environmental studies, Hunting-gathering society, Man and Environment and public awareness, The Earth, origin of earth, origin of solar system, origin of Biospehere, Origin of life, Earth's structure, The Environment, Techno-ecosystems.

Ecosystem (Abiotic and Biotic factors), Ecological adaptations, Plant adaptation (morphological and anatomical), Ecosystem structure: Biotic components, abiotic substances, trophic level, food chain, food web, Aquatic ecosystems, Marine ecosystems, Wetland ecosystems, Grassland ecosystems, Forest ecosystems.

Ecosystem structure and function: Energy flow in the ecosystem, Primary production (methods of measurement), decomposition, energy dynamics (trophic organisation, energy flow pathways, ecological efficiencies, Energy dynamics, concept of energy subsidy, universal energy flow, cybernetics, Ecological pyramids, Bio-geo-chemical cycles, The Gaia hypothesis, Geo-chemical cycles (Hydrological cycles, gaseous cycles, sedimentary cycles).

Population ecology: Population interactions (population density, natality, mortality, population age structure, carrying capacity, Community ecology: Ecological communities and ecosystems, structural analysis of communities, inter- and intra-specific competitions, Mutualism and commensalism, predation, parasitism, amensalism, competition and coexistence, Habitat and ecological niche.

Ecological regulation: System studies, Chemical transformations, Biochemical transformations, ecological succession, Mechanism of ecological succession and characters of succession, Process of succession, climax concept, Hydrosere, xerosere, ecological biodiversity.

Select text books for reading:

Panigrahi, A. K. and Alaka Sahu (2012): Text book on Environmental Studies. Giribala Publishing House, Berhampur.
Gomez, K. A. and Gomez, A. A. ((1984). Statistical Procedures for Agricultural Research, 2nd Ed. John Weley, New York.
Kormondy, E. J. (1996). Concepts of Ecology, Prentice-Hall India, New Delhi.
Odum, E. P. (1971). Fundamentals of Ecology, Saundas, Philadelphia, USA.
Misra, B. N. and Misra, M. K. (1998). Introductory Practical Biostatistics, Naya prokash, kolkata.
Smith, R. L. (1996). Ecology and Field Biology. Harper Collins, New York.
Subrahmanyam, N. S. and Sambamurty, A. V. S. S. (2000). Ecology. Narosa, New Delhi.

PRACTICAL PAPER:

Paper I.5: Based on Theory Papers I.1 & I.2.
Paper I.6: Based on Theory Papers I.3 & I.4.

SECOND SEMESTER
PAPER – 2.1
MOLECULAR BIOLOGY AND GENETICS

Genetics: Mendelism and deviation of Mendelian ratios, epistasis, linkage and crossing over, sex-linked inheritance, three point test cross and chromosome mapping, Extra chromosomal inheritance.

Cytogenetics: Structural Chromosomal aberrations: duplication, deficiency, inversion and translocations heterozygotes; Numerical chromosome aberrations: aneuploids: trisomics and monosomics; euploids: autopolyploids, allopolyploids, role polyploidy in speciation with reference to *Triticum* and *Brassica*.

Molecular Genetics: Prokaryotic and eukaryotic DNA replication: DNA polymerases, replisome, replicon, primase, telomerase.

RNA transcription: mRNA, tRNA, rRNA, siRNA, miRNA, RNAi, RNA polymerases, RNA-processing, RNA splicing, spliceosome, RNA editing. Genetic code.

Protein translation, inhibitors of replication, transcription and translation, post-translational modifications, protein targeting.

Regulation of gene expression in prokaryotes and eukaryotes: role of chromatin in regulating gene expression and gene silencing.

Gene fine structure, cis-trans test; *in situ* hybridization concept and techniques, physical mapping of genes on chromosomes, FISH and GISH.

Mutagenesis, DNA damage and repair: Spontaneous and induced mutations, physical and chemical mutagens, molecular basis of mutations, transposable elements in prokaryotes and eukaryotes, mutations induced by transposons, site directed mutagenesis, DNA damage and repair mechanisms. Environmental mutagenesis and genetic toxicology.

Select text books for reading:

Lewin, B. (2004). Gene VIII. Person-Prentice Hall, London.

Pierce, B. A. (2006). Genetics: A Conceptual Approach. W. H. Freeman, New York.

PAPER – 2.2
ADVANCE PLANT PHYSIOLOGY AND METABOLISM

Membrane transport and translocation of water and solutes: Plant water relation, mechanism of water transport through xylem, phloem loading and uploading, passive and active solute transport, membrane transport proteins.

Photosynthesis: Light harvesting complex, structure and chemistry, Photolysis of water and Hill Reaction, Photo-phosphorylation, CO_2-fixation, C_3 and C_4 and CAM pathways,

Respiration and lipid metabolism: Glycolysis, Fermentation, TCA cycle, pentose phosphate path ways, mitochondrial electron transport and ATP synthesis, alternate oxidase, photorespiratory pathway; lipid metabolism: fatty acid biosynthesis, synthesis of membrane lipids, storage lipids and their catabolism.

Nitrogen fixation and nitrogen metabolism: Biological nitrogen fixation, asymbiotic abd symbiotic nitrogen fixation nodule formation, nod and *nif* genes their regulation and function, mechanism of nitrate uptake and reduction, ammonium transport and assimilation.

Stress Physiology: Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress.

Oxidative metabolism: reactive oxygen species (ROS), antioxidants, antioxidant enzymes: catalase, peroxidases, superoxide dismutase, glutathione transferase, glutathione reductase, *Halliwell–Asada cycle*.

Physiology of aging and senescence, influence of hormones and environmental factors on senescence. Programmed cell death.

Sensory Biology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal physiology; phytohormones: ethylene, abscisic acid, brassinosteroids, polyamines, jasmonic acid.

Select text books for reading: Buchachnanan, B. B., Grissem, W. and Jones, R. L. J., (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Rockville, USA.

Devlin, R. N. and Witham, F. H. (1983). Plant Physiology. CBS Publishers, Delhi.

Salisbury, F. B. and Ross, C. W. (1991). Plant Physiology, Wordworth Publication California, USA.

PAPER – 2.3
ADVANCE PLANT BIOCHEMISTRY AND BIOSTATISTICS

Basics of Biochemistry: Structure of atoms, molecules, chemical bonds, stabilising interactions (Van der Waals, electrostatic, hydrogen bonding and hydrophobic interactions.

Principle of biophysical chemistry and bioenergetics: pH, buffer, reaction kinetics, thermodynamics, colligative properties., couples reactions, group transfer, biological energy transfer.

Biomolecules: Composition, structure, and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Confirmation and stability of proteins (Ramachandra plot, secondary, tertiary and quaternary structure, domains, motif, and folds). Confirmation and stability of nucleic acids (A-, B-, Z- DNA, t-RNA, mi RNA), phenols, terpenes.

Plant enzymes and Coenzymes: Nomenclature and classification of enzymes and coenzymes: Distribution of enzymes in plant, structure and function of Isoenzymes. Enzyme kinetics, mechanism of enzyme action and its regulation. Factors affecting enzyme action.

Antioxidants: structure and functions of ascorbic acid, glutathione, tocopherol, carotenoids etc.

Biostatistics: Frequency distribution, cumulative and relative frequency. Measurement of central tendency and dispersion, mean, median and mode, mean deviations, variance and standard deviation, coefficient of variation, errors. Analysis of variance (ANOVA). Comparison of means: Students 't' test and paired 't' test. Chi-square (X^2) test, 2 x 2 contingency table and association analysis as applied to biological experimental data. Simple correlation and linear regression analysis.

Select text books for reading:

Boyer, R. (2004). Modern Experimental Biochemcistry, 3rd Ed. Perason Educational Publication, Singapore.

Buchachnanan, B. B., Grissem, W. and Jones, R. L. J., (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant physiologists, Rockville, USA

Goodwin, T. W. and Mercer, E. I. (1985). Introduction to Plant Biochemistry, 2nd ed. Pergamon, Oxford.

Mathews, C. K., Van Holde, K. E. and Ahern, K. G. (2000). Biochemistry, Addison-Wesley Publishing Company, San Francisco, USA.

PAPER – 2.4
ENVIRONMENTAL POLLUTION AND MANAGEMENT

Environmental Pollution and control: Air pollution, water pollution, terrestrial/ soil pollution, noise pollution, and radiation pollution.

Biological-concentration and biomagnification of pesticides and heavy metals in the ecosystem.

Environmental laws, environmental education and awareness.

Thermal pollution: Ozone layer depletion, Greenhouse gases (GHG), Global warming and climate change, and consequences of climate change: smog, acid rain etc.

Industrial pollution: Nature and effects, treatment of chemical wastes, sewage and sewage treatment, Abatement of pollution, chemical pollutants, bio-wastes and managements.

Environmental Pollution and Legislative solution: legal remedies against pollution, Environmental Protection Act (EPA), water act, air act, environment act, Pollution Control Board, Disaster and disaster management.

Environmental education and awareness, environmental audit, environmental management, environmental crisis, environmental ethics.

PRACTICAL PAPERS:

Paper 2.5: Based on Theory Papers 2.1 & 2.2

Paper 2.6: Based on Theory Papers 2.3 & 2.4

Select text books for reading:

Panigrahi, A. K. and Alaka Sahu (2012): Text book on Environmental Studies. Giribala Publishing House, Berhampur.

Hill, M. K. (1997). Understanding Environmental Pollution. Cambridge University Press, UK.

Mason, C. F. (1991). Biology of Freshwater Pollution. Longman, New York.

Third Semester Examination

Paper – 3. 1

Plant Diversity iii: Systematics of Angiosperms and Economic Botany

Taxonomic Structure: Taxonomic hierarchy; Concept of species, genus and family, Plant Nomenclature: Salient features of International Code of Botanical Nomenclature (ICBN), Major rules: priority, effective and valid publications and author citation. Type concept, Taxonomic Tools**:** Field and Herbarium techniques; Floras and Botanic Gardens, Computer and Taxonomy.

Systems of Angiosperm Classification: Artificial, natural and phylogenetic systems, relative merits and demerits of major systems of classification (Bentham and Hooker, Engler and Prantle, Hutchinson and Takthajan). Taxonomic Evidences: Morphology, anatomy, palynology, embryology, cytology, phytochemistry and serology.

Angiosperm Families: Floral structure and phylogenetic relationship among the taxa under the following orders: Liliflorales, Scitaminae, Orchidales, Ranales, Rosales, Tubiflorae, Malvales, Asterales and Rubiales.

World Centres of Primary Diversity of Domesticated Plants: Basic concepts, origin of agriculture and plant introduction. Origin, evolution, botany, cultivation and uses of (i) Food crops, (ii) fibre crops, (iii) medicinal and aromatic plants, and (iv) vegetable and oil-yielding crops with special reference to local plants. Plants, plant parts and plant products used in homeopathy medicines, Plants, plant parts and plant products used in ayurvedic medicines, Important timber-yielding plants, Important poisonous plants of India.

Concept of Phytogeography: Climate and Vegetation pattern of the World; Endemism, Floristic regions of India; vegetational pattern of India.

Select text books for reading:

Davis, P. H. and Heywood, V. H. (1973). Principles of Angiosperms Taxonomy. Robert E. Kreiger, New york.

Panigrahi, AK and Sahu Alaka (2002): Glossary of Economically important plants. New Central Book Agency, Calcutta.

Heywood, V. H. and Moore, D. M. (1984). Current Concepts in Plant Taxonomy. Academic press, London.

Solbrig, O. T. (1970). Principles and Methods Plant Biosystematics. MacMillan, London.

Stace, C. A. (1989). Plant taxonomy and Biosystematics. Edward Arnold, London.

Takhtajan, A. L. (1997). Diversity and Classification of Flowering Plants. Columbia University Press, New York.

Woodland, D. W. (1991). Contemporary Plant Systematics. Prentice-Hall, New Jersey, USA.

Paper – 3. 2

Natural Resources, Conservation and Utilization

Natural resources: Conservation of natural resources, Non-renewable energy resources, Alternative sources of energy, new concepts for alternative energy.

Renewable energy resources: Water resources, soil resources,

Soil conservation and management.

Principles of conservation and management; Water resources and conservation: rain water harvesting, water shed management, uses of water,

Conservation of forests: Forest as a renewable resource, deforestation, afforestation, conservation, social forestry, wild-life conservation

***In situ* conservation:** International efforts and Indian initiatives; protected areas in India – Sanctuaries, national parks, biosphere reserves, wetlands and mangroves for conservation of wild biodiversity.

***Ex situ* conservation:** Principles and practices; botanical gardens, field gene banks, seed banks, cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR).

Salient features of Biodiversity Act and rules.

Select text books for reading:

Panigrahi, A. K. and Alaka Sahu (2012): Text book on Environmental Studies. Giribala Publishing House, Berhampur.

Conway, G. and Barbier, E. (1994). Plants, Genes and Agriculture. Jones and Bartlett, Boston, USA.

Heywood, V. H. and Wyse Jackson, P. S. (1991). Tropical Botanical Gardens, Their role in Conservation and Development. Academic press, San Diego, USA.

Kothari, A. (1997). Understanding Biodiversity: Life sustainability and Equity. Orient Longman, New york.

Negi, S. S. (1993). Biodiversity and its Conseravation in India. Indus Publishing Company, New Delhi.

Simmonds, N. W. (1979). Evolution of Crop Plants. Longman, New York.

Paper – 3. 3
Plant Embryology and Plant Anatomy

Male and female gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development and gene expression; male sterility, sperm dimorphism and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos. Female gametophyte**:** Ovule development, megasporogenesis; organization of the embryo sac, structure of the embryo sac cell.

Pollination, Pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanisms and vectors, breeding system; commercial considerations, structure of the pistil, pollen stigma interactions, sporophytic and gametophytic self incompatibility (cytological, biochemical and molecular aspects), double fertilization *in vitro* fertilization.

Seed development and fruit ripening: Endosperm development during early, maturation and desiccation stages, embryogenesis, ultra-structure; cell lineages during late embryo development; storage proteins of endosperm and embryo; polyembryony, apomixis; embryo culture, dynamics of fruit growth and ripening; Latent life-dormancy; Importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy.

Plant Anatomy:

Tissue and tissue system: Meristematic tissue, distribution of mechanical tissues, apical meristem, Anomalous secondary growth (adaptive and non-adaptive), Root-shoot transition, shoot-root development, leaf development and phylotaxy, transition to flowering.

Select text books for reading:

Bewley, J. D. and Black, M. (1994). Seed: physiology of Development and Germination. Plenum, New York.

Bhojwani, S. S. and Bhatnagar, S. P. (2008). The Embryology of Angiosperms. Vikas Publishing House, New Delhi.

Raghavan, V (1997). Molecular Embryology of Flowering Plant. Cambridge University Press, Cambridge.

Raghavan, V. (1999). Developmental Biology of Flowering Plants. Springer-Verlag, New York.

Paper – 3.4
Plant Biotechnology and Plant Tissue Culture

Plant nutrition, plant cell and tissue culture: Plant micro and macronutrients, vitamins and growth hormones (auxins, gibberellins, cytokinins): physiological effects and mechanism of action, Media for plant tissue culture. General introduction, history, scope, concept of cellular differentiation, totipotency. Organogenesis and adaptive embryogenesis fundamental aspects of morphogenesis, somatic embryogenesis, androgenesis, micropropagation techniques.

Protoplasm culture: Somatic hybridization, protoplast isolation, fusion and culture, hybrid selection and regeneration. Possibilities, achievements and limitations of protoplasm research. Applications of plant tissue culture: clonal propagation, artificial seed production of hybrids, somaclones, production of secondary metabolites/natural products, cryopreservation and germplasm storage.

Plant genomics: Introduction to plant genomics, functional genomics, transcripteomics and proteomics, comparative genomics, organelle genomes (Mitochondria and Chloroplast).

Studying genomes: shotgun approach, clone contig approach, chromosome walking and jumping. Polymerase chain reaction (PCR), RT-PCR.

Analysis of genome through application of DNA fingerprinting techniques: RFLP, RAPD, AFLP, SSR, DNA micro array. Physical maps, expressed sequence tags (ESTs).

Transgenic plants: Insect-, pathogen- and herbicide-resistant plants, stress and senescence tolerant plant. Genetic manipulation of flowering pigmentation and plant nutrient content, Plant as bioreactors. Edible vaccines and plant yield.

Select text books for Reading:

Glick, B. R. and Pasternak (2003). Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, Washington, D. C., USA.

Kyte, L. and Kleyn, J. (1996). Plants From Test Tube to: an Introduction to Micropropagation, 3rd Ed. Timber press, Port land, USA.

Pollard, W. J. and Walker (1990). Plant Cell and Tissue Culture Vol VI. Humana press Clifton, USA.

PRACTICAL PAPER:

Paper – 3.5: Based on Theory Papers 3.1 & 3.2

Paper – 3.6: Based on Theory Papers 3.3 & 3.4

FOURTH SEMESTER
Paper – 4.1: Microbiology
(Special paper—Elective)

General characteristics of microorganisms: scope, history and development of microbiology, contribution of Van Leeuwenhoek- Joseph Lister, Pasteur, Koch, Jenner. **Classification of microorganisms;** Hackel's three kingdom concept, Whittaker's five, kingdom concept; Modern trends in classification of microbes.

Microbial Growth and Metabolism: Isolation and purification of microbes, maintenance, and preservation, cultural characteristics of microbes; Synchronous and asynchronous culture, continuous culture and chemostat principle. Phases of growth, Mathematical expression of growth, generation time, specific growth rate.

Microbial metabolism, heterotrophic generation of ATP, Fermentation versus respiration, Respiratory metabolism, Oxidative phyosphorylation, autotrophic generation of ATP, Chemolithotrophy, Anoxigenic bacterial photosynthesis. Fermentation pathways.

Virus: General properties, structure, purification, cultivation, principle of viral taxonomy. Bacteriophage: structure, classification, one-step growth experiment. Production of DNA phage, RNA phage, Lytic cycle, Temperate phage and Lysogeny. Animal virus and its reproduction, viral infection. Plant virus and their transmission. Anti-viral agents; M-13, Lambda, HIV, Influenza virus.

Microbes in extreme environments: Extremophiles-their nature and application, thermophilic bacteria and archaea, properties of thermophiles and thermo-enzymes, deep-sea extremophililes, halophiles, acidophiles, basophile and psychrophililes

Select text books for reading:

1) Microbioogy by Presscot, Harley and Klein's, MC Graw Hill
2) General Microbiology by R.Y. Stanier, John L. Ingraham and Mark L. Wheelis pagex, Mc Millian Press.
3) Principles of Microbiology by Ronald M. Atlas, Mc Graw Hill.
4) Microbiology by Michael J. Pcleczar, Chan and Krieg, Mac Graw Hill.
5) Fundamentals of Microbiology by Edward Alcamo, Jones and Bariett Publishers.
6) Brock- Biology of Microorganisms by Madigan, Martina and Parker, Prentice Hall.
7) Microbiology principles & Applications - J.J. Black, John Wiley, Prentice Hall
8) Michel. R. Introduction of Environmental Microbiology. 1999. ASM book

Paper – 4.2 Microbial Biotechnology
(Special paper—Elective)

Microbes in recombinant DNA technology and genetic Engineering: Restriction endonucleases, Isolation, identification and purification of DNA and mRNA, synthesis of cDNA, cloning of cDNA. Vectors for cloning: plasmids, pBR 322 and derivatives, bactriophase λ and derivatives, cosmids, construction of genome and DNA libraries.
Identification of recombinant DNA, hybridization technique, blotting techniques. Gene addition and gene subtraction (antisense) techniques. DNA synthesis and sequencing. *Agrobacterium* - the natural genetic engineer of Ti and Ri plasmid, mechanism T-DNA transfer to plant

Microbes as Biofertilisers and Biocontrol agents: Biofertilisers and their application: *Rhizobium, Azotobactor, Azospirilllum,* PGPR, Mycorrhizae, Cyanobacteria (BGA) and *Azolla*.

Microbes used in control of pest and diseases, biopesticides, BT (*Bacillus thuringenesis*), *Trichoderma*

Use of Microbes in food, feed and industry: Single cell protein: Algal protein (Chlorella, Spirulina); Fungal protein-Yeast, Mushroom cultivation; sunscreen pigments from microbes and their use: Commercial production of microbial enzymes, industrial chemicals (alkanes, butanol, ethanol, amino acid, hydrogen, organic acids), antibiotics, sterols and algal-biofuel.

Microbes in environmental management: Microbes as important component of environment, role of microbes in organic composting, Microbes as indicator of water pollution, remediation of water pollutants using biofilms, microbial soil remediation and xenobiotic degration, microbial leaching.

Select text books for reading

1) Industrial Microbiology, G. Reed (editor), CBS Publishers (AVI Publishing Company),Biology of industrial microorganisms. A.L.Demain
2) Brown T. A. Gene Cloning and DNA Analysis. Blackwell Science, London.
3) Glick, B. R. and Pasternak (2003). Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, Washington, D. C., USA.
4) Winnacker E - L, (2003). From Genes to Clones. Panima, New Delhi.
5) Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.
6) Glazer, A. N. and Nikaido, H. 1995. Microbial Biotechnology. W. H. Freeman & Company, New York, USA.
7) Gustafson, R. J. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA.
8) Henry, R. J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
9) Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
10) Old, R. W. and Primrose, S. B. 1989. Principles of Genome Analysis. Blackwell Scientific Publications. Oxford, UK.

11) Primrose, S. B.1995. Principles of Genome Analysis. Blackwell Scientific Ltd., Oxford, UK.
12) Watson, J. , Tooze and Kurtz Recombinant DNA: A short course

Paper – 4.1

Environmental Biotechnology
(Special paper—Elective)

Paper – 4.2

Environmental Management

(Special paper—Elective)

PRACTICAL PAPERS:

Paper – 4.3: Based on Theory Paper 4.1 & 4.2

Paper – 4.4: Seminar presentation

Paper – 4.5 Field study/ scientific visit/ Field survey

Paper – 4.6 DISSERTATION in lieu of 4.3 [Project work (Dissertation & Presentation)]

(The department staff council will decide whether they will opt for 4.3 or 4.6 in a particular batch for a particular year as per availability of staff / resources / funds etc.). Papers- 2.7 of second semester; 4.4 & 4.5 of 4th semester will be purely internal to be assessed by department faculty members.

[Each student will deliver two seminar presentations per year and at-least one seminar per semester. The total seminar marks will be evaluated by the department staff members and will be purely internal. The student has to submit a detailed field study / scientific visit / filed survey report through the guide/ supervisor. This paper will be evaluated by the department staff members and will be purely internal.}

The student has to carry out a project work under the guidance of any one of the faculty members on a topic on botany, plant sciences or environmental biology. The student has to present the project work in the departmental seminar which is to be evaluated (out of 50 marks) by the board of examiners consisting of the faculty members (Internal). Subsequently the student has to submit the dissertation just after theory examination for evaluation (out of 50 marks) by the examiners [One external (external of the practical examination) and respective supervisors as internal, the mean marks secured by the candidate is to be considered, which will be decided by the Head y simple calculation of external + internal marks divided by 2]