

M.Sc. Botany Syllabus

From 2005-07

THEORY PAPERS (Max. Marks each paper 80; Int.Ass. 20)

FIRST SEMESTER :

Paper-I : Biology and Diversity of Viruses, Bacteria and Fungi

- Paper-II : Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms
Paper-III : Taxonomy of Angiosperms
Paper-IV : Plant Physiology

FIRST SEMESTER : PRACTICALS (Maximum Marks 40 & Int.Ass. 10)

- Paper-I : Syllabus comprising theory papers I & II of First Semester
Paper-II : Syllabus comprising theory papers-III & IV of First Semester

SECOND SEMESTER : THEORY PAPERS (Max. Marks each paper 80)

- Paper-I : Cytology and Cell biology of plants
Paper-II : Plant Structure and Development
Paper-III : Plant Ecology
Paper-IV : Plant Metabolism

SECOND SEMESTER : PRACTICALS (Maximum Marks, each paper 40)

- Paper-I : Syllabus comprising theory papers I & II of Second Semester
Paper-II : Syllabus comprising theory papers-III & IV of Second Semester

THIRD SEMESTER : THEORY PAPERS (Max. Marks each paper 80)

- Paper-I : Genetic and Cytogenetics
Paper-II : Molecular biology of Plants
Paper-III : Plant Reproduction
Paper-IV : Plant resource utilization and conservation

THIRD SEMESTER : PRACTICALS (Maximum Marks, each paper 40)

- Paper-I : Syllabus comprising theory papers I & II of Third Semester
Paper-II : Syllabus comprising theory papers-III & IV of Third Semester

FOURTH SEMESTER : THEORY PAPERS (Max. Marks each paper 80)

- Paper-I : Plant cell, tissue and organ culture
Paper-II : Genetic engineering of plants and microbes
Paper-III : Cytogenetics of crop plants and plant breeding
Paper-IV : Plant Pathology

FOURTH SEMESTER : PRACTICALS (Maximum Marks, each paper 40)

- Paper-I : Syllabus comprising theory papers I & II of Fourth Semester
Paper-II : Syllabus comprising theory papers-III & IV of Fourth Semester

M.Sc. Botany
Syllabus (Paper-wise)
w.e.f. 2005-06

SEMESTER-I

Paper-I : BIOLOGY AND DIVERSITY OF VIRUSES, BACTERIA AND FUNGI

Unit-I

Brief account of discovery of viruses. General properties, structure, cultivation, purification, replication and transmission of viruses. Brief account of bacteriophages and plant viruses. Economic Importance.

Unit-II

Morphology and ultrastructure of bacteria. Nutritional types (autotrophs and heterotrophs), growth of bacteria. Recombination in bacteria (transformation, transduction and conjugation). General characters of Actinomycetes, Mycoplasmas and Cyanobacteria. Economic importance of bacteria.

Unit-III

Status of fungi – Kingdom Mycota. General characters, nutrition, reproduction. Heterothallism and parasexuality. Edible and poisonous mushrooms. Mushroom cultivation. Importance of fungi in agriculture and industry

Unit-IV

Classification of fungi (Ainsworth System). General account of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

REFERENCE BOOKS

1. Brock Biology of Microorganisms: by Madigan, Mortinko and Parker (2000), Prentice Hall.
2. Microbiology: by Prescott, L.M., Harley, J.P. and Klein, D.A. (1992). WCB Publishers.
3. Introductory Mycology: by Alexopoulos, C.J. Mims, C.W. and Blackwell, M. (1996). John Wiley & Sons.
4. An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press.
5. Introduction to Plant Viruses: by Mandahav, C.L. (1978). Chand & Co., New Delhi.

Semester-I

Paper-II: BIOLOGY AND DIVERSITY OF ALGAE, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

Unit-I

Algae: Classification, thallus organization and economic importance of algae. A general account on structure, reproduction, ecology and phylogenetic relationship of Cyanophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

Unit-II

Bryophytes: Classification, general characters, range of thallus organization, reproduction and evolutionary trends in Hepaticopsida, Anthocerotopsida and Bryopsida.

Unit-III

Pteridophytes: Origin and evolution of early vascular plants. Study of morphology, anatomy and reproduction of Psilopsida, Lycopsida, Sphenopsida and Pteropsida. Evolution of stele in Pteridophytes. Heterospory and origin of seed habit.

Unit-IV

Gymnosperms: Classification, distribution and economic importance. Structure and reproduction in Pteridospermales, Bennettitales, Pentoxylales, Cycadales, Cordaitales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales.

REFERENCE BOOKS

1. Kumar, H.D. 1988. **Introductory Phycology**. Affiliated East-West Press Ltd., New Delhi.
2. Morris, J. 1986. **An Introduction to the Algae**. Cambridge University Press, U.K.
3. Round, F.E. 1986. **The Biology of Algae**. Cambridge University Press, U.K.
4. Parihar, N.S. 1991. **Bryophytes**. Central Book Depot, Allahabad.
5. Parihar, N.S. 1996. **The Biology and Morphology of Pteridophytes**. Central Book Depot, Allahabad.
6. Puri, P. 1980. **Bryophytes**. Atma Ram & Sons, New Delhi.
7. Sporne, K.R. 1991. **The Morphology of Pteridophytes**. B.I. Publ. Pvt. Ltd.
8. Sporne, K.R. **The Morphology of Gymnosperme**. B.I. Publications, New Delhi.
9. Bhatnagar, S.P. and Moitra, A. 1996. **Gymnosperms**, New Age Int. Pvt. Ltd., New Delhi.

Semester-I

Paper-III: TAXONOMY OF ANGIOSPERMS

Unit-I

Taxonomy and Systematics. Principles of Plant taxonomy. Principles of ICBN. Systems of angiosperm classification. A comparison of Pre-Darwinian and Post-Darwinian classification.

Unit-II

Phylogenetic systems – relative merits and demerits of major systems of classification. Hierarchical classification. Taxonomic evidence – morphology, anatomy, palynology, Embryology, Cytology, Phytochemistry etc.

Unit-III

Process of plant identification and preparation of herbarium. Taxonomic tools – Herbarium, floras, botanical gardens (National and International), Serological and Molecular techniques.

Unit-IV

Modern taxonomy – Secondary metabolites in plants (Chemotaxonomy), Phenetic (Numerical) and Phylogenetic (Cladistic) methods. Plant explorations and introductions.

REFERENCE BOOKS

1. Cole, A.J. 1969. **Numerical Taxonomy**. Academic Press, London.
2. Davis, P.H. and Heywood, V.M. 1973. **Principles of Angiosperm Taxonomy**. Robert E. Kereiger Publ. New York.
3. Gamble, J.S. **Flora of Presidency of Madras**.
4. Harrison, H.J. 1971. **New Concepts in Flowering Plant Taxonomy**. Heiman Ednl. Books Ltd., London.
5. Radford, A.E. 1986. **Fundamentals of Plant Systematics**, Harper & Row Publ. USA.
6. Takhtajan, A.L. 1997. **Diversity and Classification of Flowering Plants**. Columbia Univ. Press, New York.
7. Woodland, D.W. 1991. **Contemporary Plant Systematics**. Prentice Hall, New Jersey.

Semester-I

Paper-IV: PLANT PHYSIOLOGY

Unit-I

Membrane transport and translocation of water and solutes: The structure and properties of water; water transport processes (diffusion, bulk flow, osmosis, water potential, components of water potential); Mechanism of water transport through xylem; Water loss by transpiration; Essential nutrients, deficiencies and plant disorders; Solute transport by passive and active mechanisms and membrane transport proteins.

Unit-II

Sensory Photobiology: History of discovery of phytochromes, structure and function of phytochrome, photochemical and biochemical properties of phytochrome, phytochrome induced plant responses, molecular mechanism of action of phytochrome in gene expression, Cryptochrome and its role in photomorphogenesis.

The flowering process: Photoperiodism and its significance, initiation of flower primordia, flowering stimulus, Vernalization, endogenous clock and its regulation.

Unit-III

Plant growth regulators: Physiological effects and mode of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, jasmonic acid and salicylic acid.

Signal transduction: Over view, receptors and G. proteins, second messengers, two component sensor regulator system in bacteria and plants, signal transduction and gene expression.

Unit-IV

Stress Physiology: Water deficit and its physiological consequences, drought tolerance mechanisms, salinity stress and plant responses, heat stress and heat shock proteins, metal toxicity, biotic stress, HR and SAR mechanisms.

REFERENCE BOOKS

1. Devline and Witham, 1986. **Plant Physiology**. CBS Pubs. and Distributors, New Delhi.
2. Hopkins, W.G. 1995. **Introduction to Plant Physiology**, John Wiley & Sons. Inc., New York, USA.
3. Moore, T.C. 1989. **Biochemistry and Physiology of Plant Hormones**. Springer Verlag, New York, USA.
4. Singhal *et al.* 1999. **Concepts in Photobiology**, Photosynthesis and Phyto-morphogenesis, Narosa Pub. House, New Delhi.
5. Taiz and Zeiger, 1998. **Plant Physiology**. Sinauer Associates Inc., Publishers, Sunderland.

Semester-I

PRACTICAL-I : BIOLOGY AND DIVERSITY OF LOWER PLANTS (Bacteria, Viruses, Fungi, Algae, Bryophytes, Pteridophytes and Gymnosperms)

A. Bacteria, Viruses and Fungi:

- Sterilization methods, preparation of media and stains.
- Isolation of bacteria from soil, air and diseased plants (Citrus canker).
- Observation of *Rhizobium* bacterioids in legume root nodules.
- Identification of fungi – Pathological anatomy of white rust, powdery mildew, rusts, smuts, tikka disease of groundnut and paddy blast.

- Identification of fungal cultures – *Rhizopus*, *Mucor*, *Aspergillus*, *Pencillium*, *Alternaria*, *Curvularia*, *Fusarium* and *Colletotrichum*.

B. Algae and Bryophytes:

Morphological study (through section cutting and permanent slides) of representative members of Algae and Bryophytes – *Microcystis*, *Anabaena*, *Rivularia*, *Hydrodictyon*, *Oedogonium*, *Ulva*, *Padina*, *Chara*, *Dictyota*, *Gracillaria*, *Polysiphonia*, *Dumortiera*, *Plagiochasma*, *Reboulia*, *Marchantia*, *Porella*, *Anthoceros*, *Sphagnum*, *Funaria*, *Polytrichum*.

C. Pteridophyts and Gymnosperms:

Observation of morphological, anatomical and reproductive structures of representative members of Pteridophytes – *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Gleichinia*, *Pterias*, *Marsilea*, *Ophioglossum*, *Isoetes*, *Osmunda* and *Azolla*.

Observation of morphological, anatomical (through C.S., RLS & TLS) and reproductive structure of gymnosperms – *Cycas*, *Cuppressus*, *Pinus*, *Araucaria*, *Ephedra*, *Gnetum*.
Observation of slides and specimen of fossil gymnosperms.

Semester-I

Practical-II : ANGIOSPERM TAXONOMY AND PLANT PHYSIOLOGY

A. Taxonomy:

- Description of a specimen from representative (locally available) families.
- Description of a specimen to study intraspecific variation and a collection exercise.
- Description of various species of a genus, location of key characters and preparation of keys at generic level.
- Location of key characters and use of keys at family level.
- Field trips within and nearby areas in the campus, compilation of field notes and preparation of herbarium sheets of such plants wild or cultivated that are abundant.
- Training in using floras and herbarium for identification of specimens described in the class.
- Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.

B. Plant Physiology:

1. Determination of water potential.
2. Estimation of chloride content
3. Demonstration of osmosis by using egg membrane.
4. Estimation of seed germination as effected by red and far-red radiation.
5. Determination of osmotic potential of cell sap by plasmolytic method.
6. Effect of osmotic potential of external solution on the rate of imbibition.
7. Determination of stomatal index, frequency and pore area.
8. Effects of chemicals and temperature on the permeability of protoplasmic membrane.
9. Determination of gibberellic acid by half seed (cereal) method.
10. Hormonal effects on senescence.
11. Seed viability test.

SEMESTER-II

Paper-I: CYTOLOGY AND CELL BIOLOGY OF PLANTS

Cytology (Unit-I & II)

Unit-I

Prokaryotic and Eukaryotic Cells: Ultrastructure of Prokaryotic and Eukaryotic cells. Ultrastructure of prokaryotic and eukaryotic chromosome; chromosome banding; Chromosomes structure and organization of DNA; Euchromatin and heterochromatin.

Special types of Chromosomes: Polytene, Lamp-brush, B-chromosomes, and Sex-chromosomes, Cell division; significance of meiosis; Karyo-type study in relation to taxonomy.

Unit-II

Structural alteration in chromosomes – Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes.

Numerical alteration in chromosomes: Origin, occurrence and induction of haploids, polyploids and aneuploids.

Cell Biology (Unit-III & IV)

Unit-III

Biomembranes: Structure and functions of biomembranes; Organelles of eukaryotic cell; Chloroplast, Mitochondria, Endoplasmic reticulum, microtubules, peroxisomes, golgi apparatus, lysosomes and plant vacuoles.

Unit-IV

Cell cycle – Phase of Cell cycle; Role of cyclins; cyclin dependent kinases, regulation of cell cycle; Apoptosis; oncogenes; tumour suppressor genes. Genomes of mitochondria and chloroplasts. Endosymbiotic theory.

REFERENCE BOOKS

1. Brown and Berke: **Text Book of Cytology**, Blackstains Sons & Co.
 2. Brachet and Mirsky (ed.): **The Cell**, Academic Press, Vols. 1-6.
 3. Darlington, C.D. : **Recent Advances in Cytology**, Blarkstains Sons & Co.
 4. Lewin, B. 2000. **Genes VII**, Oxford University Press, USA.
 5. DeRobertis, E.D.P. and De Robertis, E.M.F. 2001. **Cell and Molecular Biology**, Lippineott Williams & Wilkins, Bombay.
 6. Sharma, A.K. and Sharma, A. 1980. **Chromosome Techniques**. Theory and Practice, Butterworth.
 7. Stebbins, J.L. **Chromosomal Evolution in Higher Plants**, Edward Arnold Publ., London.
 8. Roy, S.C. and Kumar, K.D.C. 1977. **Cell Biology**, New Central Book Agency, Calcutta.
 9. Wolfe, S.L. 1993. **Molecular and Cellular Biology**, Wordsworth Publ. Co., California, USA.
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Paper-II: PLANT STRUCTURE AND DEVELOPMENT

Unit-I

Introduction: Unique features of plant development; differences between animal and plant development. Shoot development; Organization of the shoot, apical meristem (SAM); cytological and molecular analysis of SAM; control of cell division and cell to cell communication; secretory ducts and laticifers. Structure, differentiation and phylogenetic specializations of xylem and phloem.

Unit-II

Dormant and active vascular cambium and its abnormal activity, Wood development in relation to environmental factors. Leaf growth and differentiation; determination phyllotaxy, control of leaf form; differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.

Unit-III

Root development: Organization of root apical meristem (RAM); cell fates and lineages; vascular tissue differentiation; lateral roots; root hairs; root-microbe interaction.

Seed germination and seedling growth: Metabolism of nucleic acids, Proteins and mobilization of food reserves; tropisms; hormonal control of seedling growth; gene expression; use of mutants in understanding seedling development.

Unit-IV

Latent life-dormancy: Importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy; Senescence and programmed cell death (PCD); Basic concepts; types of cell death, PCD in the life cycle of plants, metabolic changes associated with senescence and its regulation, influence of hormones and environmental factors on senescence; Principles of microscopy (Light and electron microscopy).

REFERENCE BOOKS

1. Atwell, B.J. Kriederussan, P.E. and Jumbull, C.G.N. (Eds.), 1999. **Plant in action: Adaptation in nature, Performance in cultivation**, MacMillan Education, Sydney.
2. Bewley, J.D. and Black, M. 1994. **Seeds: Physiology of Development and Germination**, Plenum Press, New York.
3. Burgess, J. 1985. **An Introduction to Plant Cell Development**, Cambridge University Press, Oxford.
4. Fahn, A. 1982. **Plant Anatomy** (3rd Ed.), Pergamon Press, Oxford.
5. Fosket, D.E. 1994. **Plant Growth and Development – A Molecular approach**, Academic Press, Oxford.
6. Lyndon, R.F. 1990. **Plant Development – The Cellular basis**, Unwin Hyman, London.
7. Raghavan, V. 1999. **Developmental Biology of Flowering Plants**, Springer-Verlag, New York.
8. Steeve, T.A. and Sussex, I.M. **Patterns in Plant Development** (2nd Ed.), Cambridge University Press, Cambridge.

M.Sc. Botany Syllabus
SEMESTER-II

Paper-III - PLANT ECOLOGY

Unit-I

Structure and function of ecosystem: Biotic and abiotic components, energy flow, energy pyramids, food chains and food webs, homeostasis. Ecological life cycle, ecotype differentiation, population characteristics, and population dynamics. Community ecology, analysis of communities and ecological succession (types, mechanism, climax concept, facilitation model, initial floristic composition and inhibition models).

Unit-II

Global biogeochemical cycles of carbon, nitrogen, phosphorous, sulphur. Dynamic phytogeography: Basic principles, age and area theory, centre of origin theory, endemism, plant migration and continental drift. Climate, soil and vegetation patterns of the world; origin, structure and properties of atmosphere, horizontal and vertical movements of atmosphere; types of soils, major biomes of the world.

Unit-III

Air pollution: Classification and properties of air pollutants and their effects on plants; Ozone layer and Ozone hole; climate change. **Water pollution:** Domestic and industrial water pollution; oil pollution; **Soil pollution;** acidification, agrochemical pollution; contamination by metalliferous wastes. **Ecological Management:** Concept of sustainable development; forest conservation and soil conservation.

Unit-IV

Biological diversity: Concept and levels, role of biodiversity in ecosystem function and stability; Speciation and extinction; IUCN categories of threat; causes of biodiversity loss; conservation; keystone species.

Conventional and Non-conventional energy sources. Bioremediation and environmental clean up: Photoremediation of heavy metal pollutant sites; bio-conservation and biological degradation of hazardous wastes.

REFERENCE BOOKS

1. Brady, N.C. 1990. **The nature and properties of Soil**, MacMillan Press.
2. Begon, M. Harper, J.L. and Townsend, C.R. 1996. **Ecology**. Blackwell Science, Cambridge, USA.
3. Campman, J.L. and Reiss, M.J. 1988. **Ecology**. Principles and Applications, Cambridge University Press, U.K.
4. Kormondy, E.J. 1996. **Concepts of Ecology**. Prentice-Hall of India Pvt.Ltd., New Delhi.
5. Mitra, R. 1968. **Ecology Work Book**. Oxford and IBH, New Delhi.
6. Odum, E.P. 1983. **Basic Ecology**. Saunders, Philadelphia.
7. Ambasht, R.S. and Ambasht, N.K. 1999. **A text book of Ecology**. CBS Publ. & Distr. New Delhi.
8. Ludwig, J. and Reynolds, J.F. 1998. **Statistical Ecology**. John Wiley & Sons.
9. Sharma, P.D. 2001. **Ecology and Environment**, Rastogi Publications, Meerut.
10. Heywood, V.M. and Watson, R.T. 1985. **Global Biodiversity Assessment**, Cambridge Univ. Press, Cambridge.

Paper-IV : PLANT METABOLISM

Unit-I

Energy and Enzymes: Energy flow through living systems, principles of the thermodynamics, free energy and chemical potential, free energy of Oxidation – reduction reactions, redox potential, types of Phosphorylations, structure and functions of ATP.

Enzymes: General aspects, nomenclature and classification of enzymes, mode of enzyme action, Michaelis – Menton equation and its significance, regulation of enzymes, enzyme inhibition and isoenzymes.

Unit-II

Photochemistry and Photosynthesis: General concepts of photosynthesis, photosynthetic pigments, structure of photosynthetic apparatus, photosynthetic electron transport (Non-cycle, cyclic), proton transport and ATP synthesis.

Carbon assimilation: The carbon cycle, photorespiration and its significance, C4 and CAM pathways and their physiological and ecological significance. Biosynthesis of starch and sucrose, translocation by phloem, loading and unloading.

Unit-III

Respiration: Over view of plant respiration, glycolysis, pentose phosphate pathway, TCA cycle, electron transport, chemiosmotic hypothesis of ATP synthesis, alternative oxidase system, Alcohol and Lactic acid fermentations.

Unit-IV

Nitrogen metabolism: Sources of nitrogen to plants, biological nitrogen fixation, nodule formation and nod-factors, mechanism of nitrate uptake and reduction, ammonium assimilation (reductive amination, trans amination and GS-GOGAT). **Sulfate metabolism:** Uptake, transport and assimilation. **Lipid metabolism:** Structure and function of lipids, classification of lipids, fatty acids and their biosynthesis. Synthesis of phospholipids and storage lipids; catabolism of lipids; glyoxylate cycle.

REFERENCE BOOKS

1. Dennis *et al.*, 1997. **Plant Metabolism** (2nd ed.), Longman, Essex, England.
 2. Hopkins, W.G. 1995. **Introduction to Plant Physiology**, John Wiley & Sons, Inc., New York, USA.
 3. Nobel, P.S. 1999. **Physiochemical and Environmental Plant Physiology**, Academic Press, San Diego, USA.
 4. Taiz and Zeiger, 1998. **Plant Physiology** (2nd ed.)
 5. Voet and Voet, 1992. **Biochemistry**, John Wiley & Sons, Inc., New York, USA.
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M.Sc. Botany Syllabus

II Semester

Practical Paper-I : CYTOLOGY, CELL BIOLOGY, PLANT STRUCTURE AND DEVELOPMENT

CELL BIOLOGY, CYTOLOGY

Study of mitosis and meiosis in *Allium* and *Zea mays*.

Study of meiosis of translocation heterozygotes, observation of special types of chromosomes; salivary gland chromosomes and B-chromosomes.

Sex-chromatin identification through buccal smear.

Observation of Ultrastructural details of organells (Photographs)

PLANT STRUCTURE AND DEVELOPMENT (Laboratory/field exercises)

1. Effect of gravity, unilateral light and plant growth regulators on the growth of young seedlings.
2. Role of dark and red light/far-red light on the expansion of cotyledons and epicotylar hook opening in pea.
3. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
4. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double stained permanent slides of a suitable plant such as *Coleus*. Kalanchoes, tobacco; Examination of shoot apices in monocotyledons in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
5. Study of alternate and istrichous, alternate and superposed, opposite and superposed, opposite and decussate leaf arrangement; Examination of rosette plants (*Launaea*, *Mollugo*, *Raphanus*, *Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.
6. Microscopic examination of vertical sections of leaves such as *Cannabis*, tobacco, *Nerium*, maize and wheat to understand the internal structure of leaf tissue and trichomes, glands etc. Also study of the C₃ and C₄ leaf anatomy of plants.
7. Study of epidermal peels of leaves such as *Coccinia*, *Goillardia*, *Tradescantia*, *Notonea* etc., to study the development and fine structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.
8. Study of whole roots in monocots and dicots, examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives (use maize, aerial roots of banana, *Pistia*, *Jussieua* etc.), Origin of lateral roots and study of leguminous roots with different types of nodules.
9. Study of seed ormancy and methods to break seed dormancy.

II Semester

Practical Paper-II : PLANT ECOLOGY AND PLANT METABOLISM

ECOLOGY

1. Determination of maximum size of quadrat (area-species curve) of the grassland ecosystem.
2. Determination of minimum number of quadrats required for grass lands.
3. Determination of frequency, density and cover
4. Determination of Important Value Index (IVI)
5. Determination of leaf area index
6. Analysis of soil texture, moisture content and water holding capacity
7. Determination of per cent organic carbon and organic matter content in the soils of cropland, grass land and forest soil.
8. Estimation of dissolved oxygen content in eutrophic and oligotrophic water samples by Winkler's method.

PLANT METABOLISM

1. Separation of chloroplast pigments into two and four groups
 2. Physiological anatomy of C₃ and C₄ plants.
 3. Absorption spectrum of chlorophylls
 4. Estimation of chl *a* and chl *b* in C₃ and C₄ plants.
 5. Separation of proteins by gel electrophoresis
 6. Estimation of nitrogen and protein content of plant materials by Micro-Kjeldahl method
 7. Preparation of standard curve of proteins (BSA) and estimation of protein content in extracts of plant material by Lowry's method.
 8. Determination of aerobic and anaerobic respiration by continuous current method
 9. Determination of reducing sugars of fruits by Nelson-Somogyi's method
 10. Principles of calorimetry and spectrophotometry.
 11. Radioisotope methodology, autoradiography, instrumentation (GM and Scintillation counter) and principles involved
 12. Determination of specifications value of fats and oils
 13. Qualitative tests for carbohydrates (Iodine, Anthrone, Fehlings, Benedict etc.)
 14. Determination of V_{max} and k_m
 15. Determination of catalase activity
 16. Demonstration of polyphenol oxidase.
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Unit-I

Mendelian principles, gene interactions, Multiple allelism, quantitative or polygenic inheritance, transgressive variation, linkage and recombination, gene mapping in diploids by three point crossover data, gene mapping in haploids, by tetrad analysis in Neurospora.

Unit-II

Sex determination mechanisms in *Drosophila*, *plants* and *man*. Sex-linked inheritance, sex limited and sex influenced genes, extra chromosome inheritance, genetic recombination in bacteria, gene mapping by transformation and conjugation. Life cycle of Bacteriophages, genetic recombination in T₄ phage, cis-trans test, gene fine structure and evolution of gene concept.

Unit-III

Cytogenetics of Polyploids and Aneuploids – Autopolyploidy, its phenotypic effects, genetics chromosome pairing and breeding behaviour of autopolyploids. Allopolyploidy and genome analysis, aneuploids in plants – monosomics, trisomics, their use in chromosome mapping.

Unit-IV

The basic structure of a gene – Multigene families, Repeat sequences of centromere and telomeres of chromosome. Techniques involved in physical mapping of chromosomes *in situ* hybridization, Fluorescence *in situ* hybridization.

REFERENCE BOOKS

1. Burnham, C.R. 1962. **Discussions in Cytogenetics**, Burgess Publishing Comp. Minnesota.
2. Khush, G.S. 1973. **Cytogenetics of aneuploids**, Academic Press, New York.
3. Sybenga, J. 1975. **Meiotic configurations**. Springer Verlag, Berlin Heidelberg.
4. Lewin, B. 2004. **Gene VIII**, Prentice Hall.
5. Russel, P.J. 1998. **Genetics (5th edition)**, The Benjamin / Cummings Publishing Company, Inc., USA.
6. Sambamurthy, A.V.S.S. **Genetics**.
7. Gupta, P.K. **Cytogenetics**.
8. Strickberger, **Genetics**, Prentice Hall.

PRACTICALS

1. Meiosis in polyploids.
 2. Meiosis in translocation heterozygotes, e.g. *Rheo* sp.
 3. Induction of polyploidy using colchicine
 4. Observation of B-chromosomes in suitable material
 5. Solving genetic problems - laws of inheritance, gene interaction, recombination and gene mapping.
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M.Sc. Botany Syllabus

SEMESTER-III

Paper-II : MOLECULAR BIOLOGY OF PLANTS

Unit-I

Chemistry of the gene: Evidence for DNA as genetic material, Physical and chemical structure of DNA, Eukaryotic genome – Repeated DNA sequences, mechanism of DNA replication, DNA damage and DNA repair mechanisms.

Unit-II

Gene Expression: Transcription in prokaryotes and Eukaryotes, mRNA processing and other RNA processing events, mechanism of Translation, RNA splicing, genetic code, protein biosynthesis. Targeting of proteins to organelles.

Unit-III

Gene regulation: Principles of gene regulation, gene regulation in prokaryotes (e.g. lactose and tryptophan operons) strategies of gene regulation in Eukaryotes (e.g. DNA methylation only), Transposons, mechanism of transposition, IS elements, genetic consequences of transposition.

Unit-IV

Mapping and sequencing the genome: Linkage mapping and restriction mapping. C value and C value paradox. Cot curves, methods of DNA sequencing, microsatellites, Bioinformatics, microarray technology and its applications.

REFERENCE BOOKS

1. Alberts, B., Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1989. **Molecular Biology of the cell**, Garland Publishing Inc., New York.
2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. **Molecular Cell Biology**, W.H. Freeman and Co., New York, USA.
3. Richard, M., Twyman and Wisden, W. 1999. **Advanced Molecular Biology**, Viva Books Pvt. Ltd.
4. Turner, P.C., Mclennan, A.G., Bates, A.D. and White, M.R.H. 2001. **Instant notes on molecular biology**.
5. Snustad Peter, D. Michael J. Simmons. **Principles of Genetics**, John Wiley Sons.
6. Robert H. Tamarin. **Principles of Genetics**, Tata McGraw Hill Company.
7. Benjamin Lewin . **Genes VIII**, Prentice Hall.
8. Westhead, D.R. J.H. Parish & R.M. Twyman. **Bioinformatics**, Viva Books.

PRACTICALS

1. Assignments in Molecular Biology on related topics.
 2. Analysis of protein profiles through SDS PAGE.
 3. Estimation of DNA by DPA method.
 4. DNA sequencing by assignment.
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M.Sc. Botany Syllabus
SEMESTER-III
Paper-III : PLANT REPRODUCTION

Unit-I

Flower: Calyx, corolla, Androecium, Gynoecium; **Microsporangium:** Anther Wall, Endothecium Middle layers, Tapetum, Nuclear behaviour in tapetal cells, Sporogenous tissue; **Male Gametophyte:** Formation of vegetative and generative cells, Formation of Sperms, Pollen wall, Abnormal features. **Megasporangium:** Types of ovule, Integuments, Nucellus, Megasporogenesis, Special features. **Female Gametophyte:** Types of female gametophytes, Mature Embryo sac, Haustorial behaviour of embryo sac, Nutrition of Embryo sac.

Unit-II

Pollination: Anther dehiscence, pollen transfer, self-pollination, cross-pollination, artificial pollination, pollen storage; **Fertilization:** Pollen germination and pollen-tube growth. Path of pollen-tube, pollen-tube discharge, Double fertilization, Syngamy. **Endosperm:** Types of endosperm, ruminant endosperm, cytology of endosperm, functions of endosperm.

Unit-III

Embryo: Zygote, proembryo, Embryogeny in dicotyledons, Embryogeny in monocotyledons, suspensor, under developed and reduced embryos, Nutrition of embryo. **Polyembryony:** Causes of polyembryony, experimental induction of polyembryony, classification of polyembryony practical value of polyembryony. **Apomixis:** Vegetative reproduction, apospory, causes of apomixis, significance of apomixis.

Unit-IV

Embryology in relation to Taxonomy: Importance of Embryological characters in taxonomic considerations, families with special embryological features, examples of the value of embryology in taxonomy, Palynology in Taxonomy. **Experimental Embryology:** Effects of young seeds on fruit growth, Parthenocarpy, parasexual hybridization.

REFERENCE BOOKS

1. Bhojwani, S.S. and Bhatnagar, S.P. **The embryology of Angiosperms.**
2. Mahswari, P. **An Introduction to Embryology of Angiosperms**, 1950.
3. Shivanna, K.R. and Johri, B.M. **The Angiosperm Pollen structure and Function**, Wiley Eastern Ltd., Publications, 1989.
4. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. **Comparative Embryology of Angiosperms**, Vol. I & II, Springer-Verlag.
5. Bhojwani, S.s. and Bhatnagar, S.P. **Embryology of Angiosperms** (4th Revised and enlarged edition), 2000.

PRACTICALS

1. Training in paraffin wax method for preparation of serial sections from fixation to mounting of permanent slides.
2. Staining of slides using single and double stains
3. Demonstration of slides showing embryological peculiarities (male and female gametophytes, endosperm, embryo)
4. Introduction to techniques in experimental embryology.

M.Sc. Botany Syllabus

SEMESTER-III

Paper-IV : PLANT RESOURCE UTILIZATION AND CONSERVATION

Unit-I

Biodiversity – Current concept and status in India. Biodiversity utilisation concepts. Relationships between biodiversity and Biotechnology. Biodiversity of microbes. Role of Remote sensing in resource identification – Biopiracy-patent law – Intellectual property rights.

Unit-II

Botany, cultivation and uses of:

- 1) Food crops: Rice, Wheat and Sorghum.
- 2) Vegetable crops: Potato, tomato and chillies

Distribution, description and uses of:

- 1) Timber yielding plants: *Tectona*, *Dalbergia* and *Rosewood*.
- 2) Medicinal plants: *Rawolfia*, *Withania*, *Emblica*, *Andrographis*, *Aloe* and *Neem*.
- 3) Production and applications of biofuels – Biogas, hydrogen and methane.

Unit-III

Conservation of Biology. Current practice in conservation in India and abroad. Organisations involved in resource conservation IUCN, WWF, UNEP, UNESCO. Phytogeography – Hotspots of India and world. General account on activities of DBT, BSI and NBPGR.

Unit-IV

Strategies for *in situ* conservation – Protected areas, Wildlife sanctuaries, National parks, Biosphere reserves, mangrooves.

Strategies for *ex situ* conservation – Botanical Gardens, Seed banks, Field gene banks, *in vitro* conservation

REFERENCE BOOKS

Swaminathan, M.N. & Jain, R.S. **Biodiversity: Implications for global security**, Macmillan, 1982.

1. CSIR 1986. **The Useful Plants in India.**
2. Kothari, 1987. **Understanding biodiversity, life sustainability and equity**, Orient Longman.
3. Sharma, O.P. 1996. **Hills Economic Botany.**
4. Thakur, R.S. *et al.*, **Major Medicinal Plants.**
5. Kocchar, S.L. 1998. **Economic Botany of Tropics.**
6. Richard B. Primack. 1993. **Essentials of Conservation Biology.**
7. Heywood, V.H. & Watson, R.T. 1995. **Global Biodiversity Assessment.**
8. Peter B. Kaufman *et al.*, 1999. **Natural Products from Plants.**
9. Negi, S.S. 1993. **Biodiversity and its Conservation in India.**

PRACTICALS

1. Field survey of important plants of the region for biodiversity.
 2. Morphology, anatomy and economic important parts of the food and vegetable crops included in the theory.
 3. Study of the characters and medicinal properties of the plants included in the theory.
 4. Survey of important timber yielding trees of the region.
 5. Mapping of Hotspots and Biosphere Reserves.
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M.Sc. Botany Syllabus

SEMESTER-III

**PRACTICAL 1: GENETICS, CYTOGENETICS AND MOLECULAR BIOLOGY
OF PLANTS**

PRACTICALS:

1. Meiosis in polyploids.
2. Meiosis in translocation heterozygotes, e.g. Rheo sp.
3. Induction of polyploidy using colchicine
4. Observation of B-chromosomes in suitable material
5. Solving genetic problems - laws of inheritance, gene interaction, recombination and gene mapping.
6. Assignments in Molecular Biology on related topics.
7. Analysis of protein profiles through SDS PAGE.
8. Estimation of DNA by DPA method.
9. DNA sequencing by assignment.

M.Sc. Botany Syllabus

SEMESTER-III

**PRACTICAL 2: PLANT REPRODUCTION, PLANT RESOURCE UTILIZATION
AND CONSERVATION**

PRACTICALS

1. Training in paraffin wax method for preparation of serial sections from fixation to mounting of permanent slides
2. Staining of slides using single and double stains
3. Demonstration of slides showing embryological peculiarities (male and female gametophytes, endosperm, embryo)
4. Introduction to techniques in experimental embryology.
5. Field survey of important plants of the region for biodiversity.
6. Morphology, anatomy and economic important parts of the food, vegetable, pulse, oil-yielding and fibre crops included in the theory.
7. Study of the characters and medicinal properties of the plants included in the theory.
8. Survey of important timber yielding trees of the region.
9. Mapping of Hotspots and Biosphere Reserves.

M.Sc. Botany Syllabus

SEMESTER-IV

Paper-I : PLANT CELL, TISSUE AND ORGAN CULTURE

Unit-I

General introduction, history scope, concept of cellular differentiation and totipotency; Tissue culture media; preparation and sterilization procedures; Anther culture and production of androgenic haploids, bulbosum method.

Unit-II

Meristem culture and production of disease-free plants; Cell culture and production of secondary metabolites / natural products; Embryo culture.

Unit-III

Callus culture, somatic embryogenesis and production of synthetic seeds; Endosperm culture; Somatic hybridization: Protoplast isolation, fusion and culture, hybrid selection and regeneration possibilities.

Unit-IV

Somaclonal and gametoclonal variation; Clonal propagation; Cryopreservation, germplasm storage, and gene banks.

REFERENCE BOOKS

1. Bhojwani, S.S. and Razdan, M.K. 1996. **Plant Tissue Culture: Theory and Practice** (a revised edition). Elsevier Science Publishers, New York, USA.
2. Bhojwani, S.S. 1990. **Plant Tissue Culture: Applications and Limitations**, Elsevier Science Publisher, New York, USA.
3. Collins, H.A. and Edwards, S. 1998. **Plant Cell Culture**, Bios Scientific Publishers, Oxford, UK.
4. Hall, R.D. (Ed.) 1999. **Plant Tissue Culture: Techniques and Experiments**, Academic Press, New York.
5. Kartha, K.K. 1985. **Cryopreservation of plant cells and organs**. CRC Press, Boca Raton, Florida.
6. Khasim, S.M. 2002. **Botanical Microtechnique: Principles and Practice**, Capital Publishing Company, New Delhi.
7. Vasil, I.K. and Thorpe, T.A. 1994. **Plant Cell and Tissue Culture**, Kluwer Academic Press, The Netherlands.

PRACTICALS

Media preparation (MS medium, White's basal medium);
Inoculation of seeds of *Cajanus cajan* on agar medium;
Determination of dry and fresh weight of *in vitro* seedlings of *Cajanus cajan*;
Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed;
Isolation of protoplasts from various plant tissues and testing their viability;
Demonstration of protoplast fusion employing PEG;
Demonstration of androgenesis in *Datura*.

M.Sc. Botany Syllabus

SEMESTER-IV

Paper-II : GENETIC ENGINEERING OF PLANTS AND MICROBES

Unit-I

Recombinant DNA technology: Methods involved in generating r-DNA molecules, gene cloning-techniques, identification of clones by screening procedures, construction of genomic / c DNA libraries, PCR and its applications, Blotting techniques.

Unit-II

Genetic Engineering of plants: Plant transformation with Ti-plasmid of *Agrobacterium tumefaciens*, physical methods of transferring genes to plants, reporter genes, use of different promoters, transgenic plants. Genetically modified (GM) crops.

Unit-III

Nitrogen fixation: Mechanism and genetics of nitrogen fixation, nitrogen fixing bacteria, genetics of free living and symbiotic Diazotrophs, regulation of nif and nod gene expression, and Biofertilizers.

Unit-IV

Microbial Biotechnology: Microbes in the production of alcohol, beer, wine and vinegar. Commercial production of antibiotics, therapeutic vaccines, biopesticides. Microbes and bioremediation.

REFERENCE BOOKS

1. Lewin, B. 2000. **Gene VII**, Oxford University Press, New York, USA.
2. Sunstad, D.P. and Simmons, M.J. 2000. **Principles of Genetics**.
3. Purohit, S.S. 2000. **Biotechnology: Fundamentals and Applications**, Agrobios, New Delhi.
4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1989. **Molecular Biology of the Cell**, Garland Publishing Inc., New York.
5. Satyesh Chandra Roy and Kalyan Kumar, D.C. 1997. **Cell Biology**, New Central Book Agency, Calcutta.
6. Gupta, P.K. **Molecular Biology & Genetic Engineering**, Rastogi Publication.

PRACTICALS

1. Sketches of cloning of genes and vectors
 2. Co-cultivation of *Agro bacterium* with leaf disc method.
 3. Estimation of leghaemoglobin and nitrogen
 4. Anatomical features of legume root nodules.
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M.Sc. Botany Syllabus

SEMESTER-IV

Paper-III : CYTOGENETICS OF CROP PLANTS AND PLANT BREEDING

Unit-I

Concept and scope of Plant breeding: Principles and methods of plant breeding in self, cross and asexually propagated plants. Hardy-Weinberg law, Effect of selection in plant breeding.

Unit-II

Breeding objectives for crop improvement: Plant breeding for resistance to diseases and pests, genetics of male sterility and its applications, causes of Apomixis and breeding of apomictic crops, genetics of heterosis and its applications. Polyploidy breeding, mutation breeding and achievements.

Unit-III

Applications of Molecular markers in crop improvement: Construction of genetic maps in plants. Molecular markers – Restriction Fragment length polymorphisms (RFLPs), Random amplified polymorphic DNAs (RAPDs). Molecular maps and their utility in plant genomics.

Unit-IV

Applications of Plant Biotechnology in crop improvement: Transgenic crops - Genetic Engineering of crops for useful agronomic traits, for male sterility, food quality, improved crop productivity and molecular farming. Intellectual property rights, plant organizations, their role in crop improvement programmes.

REFERENCE BOOKS

1. Russel, P.J. 1998. **Genetics**. The Benjamin/Cummings Publishing Co., Inc., USA.
2. Khush, G.S. 1973. **Cytogenetics of Aneuploids**, Academic Press, London.
3. Gupta, P.K. 2005. **Molecular Biology and Genetic Engineering**.
4. Snustad, D.P. and Simmons, M.J. 2000. **Principles of Genetics**.
5. Chahal, G.S. and Gosal, S.S. **Principles and Procedures of Plant Breeding- Biotechnological and Conventional Approaches**, Narosa Publishing House, New Delhi.
6. Darbeshwar Roy, 2000. **Plant Breeding: Analysis and Exploitation of variation**, Narosa Publishing House, New Delhi.
7. Singh, P. 2001. **Essentials of Plant Breeding**, Kalyani Publishers, Hyderabad.

PRACTICALS

1. Calculation of gene frequencies by Hardy-Weinberg Law.
 2. Measurement of variability through standard deviation and coefficient of variation.
 3. Test of significance – t-test
 4. Calculation of heterosis
 5. Applications of RFLP and RAPD through diagrammatic sketches.
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M.Sc. Botany Syllabus

SEMESTER-IV

Paper-IV : PLANT PATHOLOGY

Unit-I

1. Concept of disease in plants; Definitions of plant disease; Historical development of Plant Pathology.
2. Methods of studying Plant diseases: collection, preservation, isolation of pathogens and proving Koch postulates.
3. Symptoms caused by plant pathogenic fungi, bacteria and viruses
4. Classification of plant diseases.

Unit-II

5. Entry of pathogens into the host
6. Role of enzymes, toxins and phytoalexins in plant pathogenesis
7. Physiological changes in diseased plants
8. Factors effecting out break of plant disease epidemics
9. Plant disease indexing
10. Plant disease forecasting

Unit-III

11. Details study of symptoms, etiology, epidemiology and control of the following fungal diseases of plants; late blight of potato, damping-off of vegetables, Taphrina leaf spot of turmeric, powdery mildew of cucurbits, ergot of bajra, black stem rust of wheat, smuts of sorghum, blast of rice, tikka disease of groundnut, red rot of sugarcane.

Unit-IV

12. Detailed study of the following bacterial and viral diseases: bacterial leaf blight of rice, angular leaf spot and black arm of cotton, citrus canker, brown rot of potato, little leaf of brinjal, tobacco mosaic disease, tungro disease of rice.
13. Principles of plant disease control: Plant quarantine, seed treatment, cultural practices, chemical control, development of disease resistant varieties.
14. Biological control of plant diseases.

REFERENCE BOOKS

1. Agrios, G.N. 1997. **Plant Pathology**, Academic Press, London.
2. Tar, S.A.J. 1972. **Principles of Plant Pathology**.
3. Singh, R.S. 1991. **Plant Diseases**, 6th Edn. Oxford & IBH Co., New Delhi.
4. Singh, R.S. 1988. **Principles of Plant Pathology**, 3rd Edn., Oxford & IBH Co., New Delhi.
5. Mehrotra, R.S. 1980. **Plant Pathology**, Tata-McGraw Hill Publishing Company, New Delhi.
6. Rangaswami, G. and Mahadevan, A. 1999. **Diseases of Crop Plants in India**, 4th Edition, Printice Hall of India Publications.

PRACTICALS

1. Field trips for collection and identification common diseases of crop plant of the region.
2. Proving of Koch postulates for at least one fungal disease and one bacterial disease.
3. Microscopic study of plant pathogen interactions – observation of stained sections of diseased materials and with respect to the diseases included in the theory and other common diseases.
4. Study of the effect of fungicides on the germination and growth of plant pathogenic fungi.

M.Sc. Botany Syllabus

SEMESTER-IV

Practical-I: PLANT CELL TISSUE CULTURE AND GENETIC ENGINEERING OF PLANTS AND MICROBES

PRACTICALS

1. Media preparation (MS medium, White's basal medium);
2. Inoculation of seeds of *Cajanus cajan* on agar medium;
3. Determination of dry and fresh weight of *in vitro* seedlings of *Cajanus cajan*;
4. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed;
5. Isolation of protoplasts from various plant tissues and testing their viability;
6. Demonstration of protoplast fusion employing PEG;
7. Demonstration of androgenesis in *Datura*.
8. Study of PCR method.
9. Sketches of cloning of genes and vectors
10. Co-cultivation of *Agro bacterium* with leaf disc method.
11. Estimation of leghaemoglobin and nitrogen
12. Anatomical features of legume root nodules.

SEMESTER-IV

Practical-II: CYTOGENETICS OF CROP PLANTS, PLANT BREEDING AND PLANT PATHOLOGY

PRACTICALS:

1. Calculation of gene frequencies by Hardy-Weinberg Law.
2. Measurement of variability through standard deviation and coefficient of variation.
3. Test of significance – t-test
4. Calculation of heterosis
5. Applications of RFLP and RAPD through diagrammatic sketches.
6. Field trips for collection and identification common diseases of crop plant of the region.
7. Proving of Koch postulates for at least one fungal disease and one bacterial disease.
8. Microscopic study of plant pathogen interactions – observation of stained sections of diseased materials and with respect to the diseases included in the theory and other common diseases.
9. Study of the effect of fungicides on the germination and growth of plant pathogenic fungi.

M.Sc. Botany

MODEL QUESTION PAPER

Max.Marks: 80

Section-A : 5 x 4 = 20 Marks

I. Write short notes on any FIVE of the following:

- (a)
- (b)
- (c)
- (d)
- (e)
- (f)
- (g)
- (h)

Section-B : 4 x 15 = 60 Marks

Answer ALL questions

II. (a) Essay question
(or)
(b) Essay question

III. (a) Essay question
(or)
(b) Essay question

IV. (a) Essay question
(or)
(b) Essay question

V. (a) Essay question
(or)
(b) Essay question

INSTRUCTIONS TO PAPER SETTERS

A

Set at least two short notes from each unit

B

Set Essay questions from each Unit giving choice within the Unit.