BOTANY

PG-Syllabus (M.Sc.)

Course code	Course	Sessional Marks	End-sem Marks	Credit
Semester-I				
BOT-PG-T101	Core Theory -1	25 + 25	50	4
BOT-PG-T102	Core Theory- 2	25 + 25	50	4
BOT-PG-T203	Core Theory- 3	25 + 25	50	4
BOT-PG-P104	Core Practical-4	50	50	4
Semester-II				
BOT-PG-T201	Core Theory-5	25 + 25	50	4
BOT-PG-T202	Open Theory-1	25 + 25	50	4
BOT-PG-T203	Core Theory-6	25 + 25	50	4
BOT-PG-P204	Core Practical-7	50	50	4
Semester-III				
BOT-PG-T301	Core Theory-8	25 + 25	50	4
BOT-PG-T302	Open Theory-2	25 + 25	50	4
BOT-PG-T303	Elective Theory-1	25 + 25	50	4
BOT-PG-P304	Elective Practical-2	50	50	4
Semester-IV				
BOT-PG-T401	Elective Theory-3	25 + 25	50	4
BOT-PG-T402	Elective Theory-4	25 + 25	50	4
BOT-PG-P403	Elective Practical-5	50	50	4
BOT-PG-D404	Dissertation and *Viva-voce*		75 +25 (Project work + Viva)	4

SEMESTER-I (Theory): CORE PAPER-I

BOTPG-CT-101: CRYPTOGAMIC BOTANY, PALAEOBOTANY, GYMNOSPERMS

Total Marks - 100 **Total Credit – 04**

Unit I: PHYCOLOGY

Algal classification and criteria. General account of different classes of algae, Thallus organization and reproduction in algae. Algae in diverse habitat, Algal blooms, Algal biotechnology, Economic importance of Algae.

Unit II: BRYOLOGY

Distribution, Morphology, structure, reproduction and life history; Classification of Bryophytes. Evolution of gametophytes and sporophytes. Ecological and economic importance of bryophytes. Detailed study of types from the three classes (Hepaticopsida, Anthocerotopsida and Bryopsida)

Unit III: PTERIDOLOGY AND PALEOBOTANY

General characters of pteridophytes, Classification of Pteridophytes. Structure and reproduction in ferns, Telome concept, Stelar evolution, Heterospory and seed habit. Economic importance of Pteridophytes, Study of Fossil Pteridophytes and Gymnosperms: Rhynia, calamites, Lepidodendron, Pteridospermales and cycadeodiales

Unit IV: GYMNOSPERMS

Classification of Gymnosperms. Comparative study vegetative, anatomical and reproductive structures of Cycadophyta, Coniferophyta and Gnetophyta. Evolutionary trends and phytogenetic relationship among various groups of Gymnosperms. Economic importance of Gymnosperms.

References:

1. Sharma, O.P. (1986) Textbook of Algae
2. Pandey, B. P. (1994) Textbook of Botany – Algae
3. Morris, J. 1986. An Introduction to the Algae. Cambridge University Press, U.K.
4. Sharma, O.O. (1989): Textbook of Fungi
5. Ainsworth, G. G. and A.S. Sussman: The Fungi Vols. I, II, III, IV- A and IV-B
6. Parihar, N.S. 1991. Bryophytes. Central Book Depot, Allahabad
7. Trivedi, A. N. (2002) - Advances in Pteridology
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
10. Sporne, K.R. 1991. The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd

SEMESTER-I (Theory): CORE PAPER-II

BOTPG-CT-102: ANGIOSPERM TAXONOMY, PLANT ECOLOGY AND PLANT ANATOMY

Total Marks - 100 **Total Credit – 04**

UNIT I: TAXONOMY AND SYSTEMATICS 15 Hrs

History of developments in taxonomy: merits and demerits of major systems of classification. Angiosperm Phylogeny Group (APG) system of classification (APG III and IV); biosystematics; concepts and components; Aims of systematics; direct and indirect methods of plant identification; practice of taxonomic key; diversity and taxonomic studies of flowering plants of North-Eastern India with special reference to primitive and advanced taxa.

UNIT II: TAXONOMIC HIERARCHY 15 Hrs

Introduction: concept of species, and speciation; theories relating to evolution of angiosperm; important Indian and world herbaria; taxonomic literature (floras, taxonomic accounts, revisionary studies); computer aided studies. Salient features of International Code of Botanical Nomenclature (ICN); principles of the code; ranks of taxa; rules of priority and limitations of principles of priority; effective and valid publications; *nomen nudum*, later homonym; type method and typification; *nomen alternatum*.

UNIT III: FUNDAMENTAL OF ECOLOGY 15 Hrs

Introduction to ecology; evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. Competition and coexistence; specific interactions, ecological niche, keystone species, ecotypes. Nature of ecosystem, production, food webs, energy flow through ecosystem, biogeochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes.

UNIT IV: PLANT ANATOMY 15 Hrs

Anatomy in relation to taxonomy; secondary growth and nodal anatomy, the node-internode transition, formation of leaf and branch traces. Wood histology, growth rings, tracheids, vessels and wood rays, longitudinal parenchyma and its arrangement, grain and texture, knots, formation of resin cavities and tyloses. Anatomy of floral axis and the whorls, the leaf, origin of carpel, types and distribution of lactifers and lenticels, anatomy in relation to their physiological roles. Applications (in brief) of anatomical studies in systematics, climate studies, pharmacology, forensic sciences.

Suggested readings

1. Angiosperm Phylogeny Group. (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of
2. Carlquist S (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.
3. Conklin, A.R. Jr. 2004. Field Sampling: Principles and Practices in Environmental Analysis.
4. Cutler DF (1978). Applied Plant Anatomy, Longman, United Kindom
5. Cutter EG (1978). Plant Anatomy, Part I & II, Edward Arnold, United Kingdom.
6. Cutter, E.G. (1971). Plant anatomy: Experiment and Interpretation, Part II, Organs Edward Arnold, London.
7. Cronquist A (1981). An integrated system of classification of flowering plants. Columbia University Press, New York.
8. Davis, P.H. and Heywood, V.H. (1965). Principles of Angiosperm Taxonomy. D Van Nostrand Co., New York.
9. Dickinson WC (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
10. Eames, A.J. and MacDaniels, L.H. (1947). An Introduction to the Plant Anatomy (2nd Ed.), McGraw Book Comp., New York. Elsevier Academic Press, USA.

SEMESTER-I (Theory): CORE PAPER-III

BOTPG-CT-103: PLANT DEVELOPMENT AND REPRODUCTION

Total Marks - 100 **Total Credit – 04**

UNIT I: GENERAL FEATURES OF PLANT DEVELOPMENT

Plant growth kinetics and patterns of growth. Seedling growth: Tropisms; Photomorphogenesis of seedling; Shoot Development: Organization of shoot apical meristem (SAM); tissue differentiation in the shoot.

UNIT II: LEAF, ROOT AND FLOWER DEVELOPMENT

Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata & trichomes) and mesophyll.
Root Development: Organization of root apical meristem (RAM); vascular tissue differentiation; lateral root hairs; root microbe interactions. Flower Development: Physiology of flowering, florigen concept and photoperiodism, Pollination mechanisms and vectors.

UNIT III: DEVELOPMENT OF REPRODUCTIVE STRUCTURES

Male Gametophyte: Structure of anther, microsporogenesis, tapetum; pollen development and gene expression; male sterility; sperm dimorphism; pollen germination; pollen tube growth and guidance. Female Gametophyte: Ovule types; megasporogenesis; organization of embryo sac; structure of embryo sac cells. Pollen-pistil interaction, self-incompatibility and fertilization; Structure of the pistil; pollen-stigma interactions, double fertilization; in vitro fertilization.

UNIT IV: FRUIT AND SEED DEVELOPMENT

Seed Development and fruit growth: Endosperm development; embryogenesis; ultrastructure and nuclear cytology; storage proteins of endosperm and embryo; polyembryony; apomixes; embryo. Fruit development and growth. Dormancy; Importance and types of dormancy; seed dormancy; overcoming seed dormancy; bud dormancy.

References:

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Fageri, K. and Van der Pol, L. 1979. The Principles of Pollination Ecology. Pergamon Press, Oxford. 3) Fahn, A. 1982.
3. Fosket, D.E. 1994. Plant Growth and Development.A molecular Approach. Academic Press, San Diego.
4. Howell, S.H. 1998, Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.
5. Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Floral Development. J. Cramer, Germany.
6. Lyndon, R.F., 1990. Plant Development.The Cellular Basis. Unnin Hyman, London.
7. Murphy, T.M. and Thompson, W.F. 1988. Molecular PlantDevelopment. Prentice Hall, New Jersey.
8. Proctor, M. and Yeo, P. 1973. The Pollination of Flowers.William Collins Sons, London. 10) Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
9. Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer -Verlag, New York.
10. Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1992. Biology of Plants (5th Edition).worth, New York.

SEMESTER-I (Practical): CORE PAPER-IV

BOTPG-CP-104: TAXONOMY, CRYPTOGAMS AND ANATOMY LAB

Max. Marks-100 **Total Credit-04**

1. Use of floras and manuals for plant identifications.
2. Field, herbarium methods and preparation of herbarium, museum specimens. (Students are required to submit at least twenty digital specimens).
3. Handling of taxonomic softwares.
4. Field visits for taxonomic study (minimum -2).
5. Morphological study of representative members of bryophytes: *Marchantia, Porella, Anthoceros, Sphagnum, Funaria, Polytrichum*, *Riccia, Bryum*.
6. Observation of morphological, anatomical and reproductive structures of representative members of Pteridophytes – *Psilotum, Lycopodium, Selaginella, Equisetum, Gleichenia, Pteris, Marsilea, Isoetes, Azolla*, *Cyathea.*
7. Observation of anatomical (through C.S., RLS & TLS) structure of gymnosperms – *Cycas, Cupressus, Pinus, Araucaria, Ephedra, Gnetum*.
8. Study of paleobotany through permanent slides and fossil specimens
9. Study of anomalous secondary growth of monocotyledon and dicotyledon root, stem and leaf.
10. Anatomical basis of identification C3 & C4 sub types in grasses.
11. Anatomy of lenticels and periderm in plants.
12. Study of stomatal types.

Suggested Readings:

1. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
3. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002) Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
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. Semple C and Steel MA (2003) Phylogenetics. Oxford University Press, Oxford.
8. Simpson MG (2006) Plant Systematics. Elsevier, Amsterdam.
9. Sporne, K.R. (1991). The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd
10. Sporne, K.R. The Morphology of Gymnosperme. B.I. Publications, New Delhi.

SEMESTER-II

SEMESTER II (Theory): CORE PAPER-V

BOTPG-CT-201: CYTOGENETICS, PLANT BREEDING, EVOLUTION, BIOSTATISTICS

Total Max. Marks-100 **Total Credit-04**

UNIT-I: CELL BIOLOGY AND CYTOGENETICS **15 Hrs**

Ultra structure of plant cell organelles, cell cycle, cytoskeleton in plants. Inheritance- classical and modern perspectives, linkage and crossing over, multiple allelism, gene interaction, Pleiotrophy and epistasis.

UNIT-II: PLANT BREEDING **15 Hrs**

Domestication, genetic variability, selection, hybridization, self and cross pollination, apomixes and back cross technique & importance; heterosis breeding, wide hybridization, GXE interactions, Importance and applications of plant breeding.

UNIT-III: EVOLUTION **15 Hrs**

Origin and evolution of life - theories of evolution: Lamarkism, Darwinism and principles of Hugo *de* Vries. Mechanisms of evolution- natural selection, gene flow, Hardy-Weinberg equilibrium, genetic drift. Modes of speciation- sympatric, peripatric, parapatric and allopatric. Population genetics, methods of studying population structure.

UNIT-IV: BIOSTATISTICS **15 Hrs**

General concepts and terminology; Sampling methods; Measures of location, scale and shape, contingency tables and chi-square test; comparison of means: t-test, multiple range tests; Simple experimental design and analysis of variance; Correlation and regression analysis; Introduction to multivariate methods.

REFERENCES

1. Kulas JT (2008) SPSS Essential: Managing and Analyzing Social Science Data. John Wiley & Sons, New York.
2. Pagano M, Gauvreau K (2007) Principles of Biostatistics. Thomson India Edition, New Delhi.
3. Randal Schwartz, Tom Phoenix and Brian d Foy (2005) Learning Perl (4th edition), O'Reilly & Associates, ISBN: 0-596-10105-8.
4. Rex A. Dwyer (2004) Genomic Perl: From Bioinformatics Basics to Working Code, Cambridge University Press, 1st South Asian Edition.
5. Kulas JT (2008). SPSS Essential: Managing and Analyzing Social Science Data. John Wiley & Sons, New York.
6. Pagano M, Gauvreau K (2007). Principles of Biostatistics. Thomson India Edition, New Delhi.
7. Randal Schwartz, Tom Phoenix and Brian d Foy (2005). Learning Perl (4th edition), O'Reilly & Associates, ISBN: 0-596-10105-8.
8. Rex A. Dwyer (2004). Genomic Perl: From Bioinformatics Basics to Working Code, Cambridge University Press, 1st South Asian Edition.

SEMESTER II (Theory) : OPEN PAPER-I

BOTPG-OT-202: BIODIVERSITY, PHYTOGEOGRAPHY, ENVIRONMENTAL SCIENCE

Total Max. Marks-100 **Total Credit-04**

UNIT I: BIODIVERSITY **15 Hrs**

Biodiversity scenario at global, national and regional level. Biodiversity monitoring and assessment; Biodiversity act of India and related international conventions. Estimating changes in biodiversity. The future of biodiversity. Hotspots of biodiversity; threats to biodiversity (IUCN categories); Biodiversity conservation-Indian case studies on conservation.

Unit II: CONSERVATION PLANNING AND CLIMATE CHANGE **15 Hrs**

Conservation planning and Climate change. Bioclimatic envelope Model for individual species; Climate Change -Integrated strategies for Conservation; Climate change prediction, REDD+, Synergies between Sustainable use of Biodiversity and Climate change, consequence of climate, ozone layer depletion.

UNIT II: PHYTOGEOGRAPHY **15 Hrs**

Dynamic or interpretative plant geography; principles and concepts of phytogeography; Botanical provinces of India; Vegetation of India. Floristic regions of India; Endemism-centre of origin, vicariance, theories of endemism, factors for endemism, endemic plants; continental drift.

UNIT IV: ENVIRONMENTAL SCIENCE **15 Hrs**

Introduction to environmental science and sustainability, environmental laws. EIA, general guidelines for the preparation of environmental impact statement. Scope and types of environmental audit, energy audit, cost benefit analysis. Environmental management plan, ISO 14000 standards and certification. Environmental risk management and environmental safety norms. International summits and treaties related with environment. Applications of GIS and RS technology in environmental studies,

Suggested Reading:

1. Adams LW. (1994). Urban Wildlife Habitats. Minneapolis: University of Minnesota Press.
2. Albert et al. (2003). Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. Bioscience 53(12): 1169-1179.
3. Barnes, R.S.K. (1998). Diversity of living organisms. Blackwell Sciences Ltd., U.K.
4. Barthlott, W. and Winiger, W. (2001). Biodiversity. Springer-Verlag, New York.
5. Champion HG, Seth SK. (1968). A revised survey of the forest types of India. (Reprinted in 2005). Dehara Dun, India: Natraj Publishers. p. 251–337.
6. Cracknell AP, Hayes L (2009). Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
7. Dallimer M., Irvine K.N., Skinner A.M.J., Davies Z.G., Armsworth P.R., Rouquette J.R., Maltby L.L., Warren P.H., Gaston K.J. (2012). Biodiversity and the feel-good factor: understanding associations between self-reported human well-being and species richness. BioScience 62: 47-55
8. David Briggs, Stuart Max Walters (1997). Plant Variation and Evolution, Cambridge University Press.
9. Eldredge, N. (1992). Systematics, Ecology and Biodiversity Crisis. Cambridge University Press, New York.
10. Ellis, E. C. (2013). Sustaining biodiversity and people in the world's anthropogenic biomes Current Opinion in Environmental Sustainability, 5:368–372

SEMESTER II (Theory): CORE PAPER-VI

BOTPG-CT-203: MICROBIOLOGY, MYCOLOGY, PLANT PATHOLOGY

Total Max. Marks-100 **Total Credit-04**

UNIT- I: INTRODUCRTION TO MICROBIOLOGY 15 Hrs.

History, branches and scope of Microbiology. Study about major groups of microorganisms. Characterization: Morphological characteristics, chemical characteristics, cultural characteristics, metabolic characteristics, antigenic characteristics, genetic characteristics, pathogenicity, ecological characteristics of microorganisms. Classification, nomenclature and identification of microorganisms. Culture media, culture methods, Pure culture techniques, Maintenance and preservation of pure culture. Reproduction and growth of bacteria.

UNIT-II: MYCOLOGY 15 Hrs.

Historical introduction of mycology. General characteristics of fungi. Fungal classification (Ainsworth and Alexopoulos). General accounts of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Dueteromycotina with representative classes. Lichens: Thallus structure, reproduction and economic importance. Economic importance of Fungi.

UNIT-III: PLANT PATHOLOGY 15 Hrs.

Historical and developmental aspects of Plant pathology. Outline of classification of plant diseases. Pathogenesis: penetration; development inside the host tissue. Defense mechanisms of plants against infection: Preexisting and postexisting structural defense. Biochemical defense, hypersensitive reaction, SAR, role of phytoalexins and other phenolic compounds. Plant/microbes/pests interaction.

UNIT-IV: PLANT DISEASES 15 Hrs.

Symptoms, etiology and control measures of some important diseases of the following crops: Rice, Wheat, Potato, Sugarcane and Tea.

REFERENCES

1. R.C.Dubey and Maheshwari.D.K.2002. A Text book of Microbiology, S.C.Chand and Company, Ltd. Ramnagar, New Delhi.
2. S.B.Sullia and Shantharam. S.1998. General Microbiology. Oxford and IBH publishing Co.Pvt.Ltd. New Delhi.
3. Sharma. P.D.1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
4. Ananthnarayan, R and Jayaram Panikar,C.K. 1986. Text book of Microbiology. Orient Longman ltd. New Delhi.
5. Brook, T.D. Smith, D.W and Madigan, M.T. 1984. Biology of Microorganisms, 4th ed. Eaglewood Cliffts. N.J.Prentice- Hall. New Delhi.
6. Claus, William, G.1989. Understanding microbes. A laboratory text book for Microbiology. W.H.Freeman and Company. New York.
7. Ketchum, PA. 1988. Microbiology, concepts and applications. John Wiley and Sons. New York.
8. Stainer, Roger, Y. Ingrahan, John, L. Wheelis, Mark,L and Painter, Page,R. 1990. Microbial World 5th edition. Prentice-Hall India, Pvt.Ltd. New Delhi.
9. Schlegel, H.G.1986. General Microbiology. Cambridge University Press. London, 587pp.
10. Sharma, R.2006. Text book of Microbiology. Mittal Publications. New Delhi. 305pp.

SEMESTER II (Practical): CORE PAPER-VII

BOTPG-CP-204: CYTOLOGY, MICROBIOLOGY AND PLANT PATHOLOGY LAB
Total Max. Marks-100 **Total Credit-04**

CYTOLOGY

1. Preparation of pre-treating and fixative agents in the laboratory
2. Preparation of some cytological stains in the laboratory
3. Preparation and study of mitosis [*Allium cepa* (Onion), *Allium sativum* (Garlic), *Pisum sativum* (Pea), *Cicer aerietinum* (Gram), *Nigella sativa* (Black cumin), *Vicia faba* (Broad bean), *Aloe indica*].
4. Preparation and study of meiosis (Family Liliaceae, Ranunculaceae/Papaveraceae, Solanaceae)
5. Study of giant chromosome
6. Demonstration of hybridization techniques

MICROBIOLOGY AND PLANT PATHOLOGY LAB

1. Culture media preparation: Solid media: PDA, NA; Liquid media: NB. Preparation of agar slants, method of inoculum transfer.
2. Sterilization with moist heat, dry heat, filtration, radiation.
3. Different types of bacterial staining - Simple, Gram's, Endospore staining Negative staining.
4. Pure culture technique of bacteria: Streak plate method/poor plate method.
5. Study of Symptoms, Causes and control measures of the following diseases related to local crops: Large Cardomom, Ginger, banana, Bacterial leaf blight of rice, bacterial leaf streak of rice, stem rot of rice, any other locally relevant crops.
6. Collection and submission of plant disease sample.

References:

1. S.C.Santra, T.P.Chatterjee & A.P.Das (2012). College Botany-Practical (Vol.1).New Central Book Agency (P) Ltd. 8/1 Chintamoni Das Lane, Kolkata-700009.
2. S.C.Santra, T.P.Chatterjee & A.P.Das (2010). College Botany-Practical (Vol.2).New Central Book Agency (P) Ltd. 8/1 Chintamoni Das Lane, Kolkata-700009.
3. Mehrotra, R.S, and Ashok Aggarwal, 2004. Plant pathology
4. Mukta Bhargava, 2003. The latest portfolio of theory and practice in Fungi, A.S Saini Dominant publications.
5. Sambamurthy A.V. S.S. 2006. A Textbook of Plant Pathology. I.K. International Pvt.Ltd., New Delhi.
6. Ananthanarayanan, R. and CKJ. Paniker, 2004. Textbook of Microbiology. Orient Longman.
7. Dubey, R.C. and D.K. Maheswari, 2007. A Textbook of Microbiology, S. Chand & Company.

SEMESTER-III

SEMESTER-III (Theory): CORE PAPER-VIII

BOTPG-CT-301: BIOCHEMISTRY, PHYSIOLOGY & MOLECULAR BIOLOGY

Total Max. Marks-100 **Total Credit-04**

UNIT-I: PLANT PHYSIOLOGY 15 Hrs.

Water relations: water absorption and transport, membrane transport

Photochemistry: Light harvesting system, mechanism of electron and proton transport in photosynthesis, Calvin-Benson cycle, C2 and C4 carbon cycle, CAM

Respiration: Glycolysis, Citric acid cycle, Electron transport chain

Biological nitrogen fixation; Biology of Nodule formation; Mechanism of nitrate uptake, reduction and ammonium assimilation, sulphate uptake and assimilation.

Sensory Photobiology: Structure, function and mechanisms of action of phytochromes and cryptochromes .

UNIT-II: BIOCHEMISTRY **15** Hrs.

Carbohydrates: Mo, di and polysaccharides, glycoproteins

Protein: Primary structure of protein, secondary, tertiary and quaternary structures, prediction of secondary structure of protein, prions.

Lipids: classification, chemical structures and physical properties.

Enzymes: Nature and classification of enzymes, kinetics, bisubstrate reaction.

UNIT-III INTRODUCTION TO MOLECULAR BIOLOGY 15 Hrs.

History of DNA molecule & discoveries, structure of nucleic acids, physical and chemical stability of nucleotides, bonding, double helix and features. Factors affecting the DNA structure, concept of gene structure. Functional attributes of genes at molecular level. DNA replication.

UNIT-IV: PROTEIN BIOSYNTHESIS 15 Hrs.

Transcription: mechanism in prokaryotes & eukaryotes – RNA-Polymerases, initiation, elongation and termination. Post transcriptional modifications. Translation - mRNA organization, the genetic code, translation machinery, deciphering the code, translation in *E. coli* and differences in eukaryotes. Post translational modifications.

REFERENCES

1. Cooper Jeoffrey M-2013: Cell-A Molecular Approach, 6th Edition. Sinauer Assoc. Inc. USA
2. Jocelyn E Krebs et al. 2010. Lewin's Gene X. Jones And Bartlett Publishers, Inc USA.
3. Watson and others – 2004 : Molecular Biology of the gene (V); Pearses Educatias, Inc India
4. P.C. Turner and others – 2002 : Molecular Biology (II); Viva Books, Pvt. Ltd., New Delhi.
5. W. Ream and KG. Field – 1999 : Molecular Biology Techniques ; Academic Press, London.
6. Brace Alberts et al – 1983 : Molecular Biology of the cell ; Garland Publ. Inc., New Yorsk.
7. Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Rockville, USA.
8. C. K. Matthews, K. E. Van Holde and K. G. Ahern. (2007).Biochemistry, 3rd Edition, Pearson Education, New Delhi
9. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA.
10. D. R. Ferrier. (2015). Lippincott's illustrated Reviews: Biochemistry, 6th Edition. Wolters Kluwer (India) Pvt Ltd, New Delhi

SEMESTER-III (Theory): OPEN PAPER-II

BOTPG-OT-302: PLANT RESOURCES UTILIZATION

Total Max. Marks-100 **Total Credit-04**

UNIT-I: PLANT RESOURCES UTILIZATION **15 HRS**

Diversity and distribution of exploited/underexploited/unexploited plants of economic value of Himalaya and the north eastern region; Use of plants by indigenous communities in Himalaya and the north eastern India for subsistence, medicine and cultural and religious rituals; value addition and product development of some economically important plants.

UNIT-II: BIOPROCESS DEVELOPMENT **15 HRS**

Plant cell culture platforms; Plant growth regulators and elicitors; cell suspension culture system: methodology, kinetics of growth and, nutrient optimization; stoichiometric consideration, production of secondary metabolites by plant suspension cultures; Hairy root culture; transgenic plants; plant products of industrial importance. Production of biomass, bioreactor types; Industrial application of chromatographic and membrane based bioseparation methods; Immobilization of biocatalysts (enzymes and cells) for bioconversion processes; Bioremediation.

Unit III: TRADITIONAL KNOWLEDGE

Traditional knowledge system of different indigenous community of Sikkim and North Eastern India. Application and practices of traditional knowledge system in agriculture, healthcare and livelihood. Sustainable utilization of biological resources and biodiversity conservation. Protection of traditional knowledge, National Biodiversity protection initiatives; Convention on Biological Diversity, Nagoya protocol.

UNIT-IV: INTELLECTUAL PROPERTY RIGHTS **15 HRS**

Intellectual property rights, types of Intellectual Property Rights and Intellectual Property protection, patents and methods of application of patents, Copyrights, Trade Marks, legal implications; protection of plant variety and farmers rights PPVFR, plant breeder's rights. Acquisition and management of IPRs.

REFERENCES:

1. Wickens GE (2004) Economic Botany: Principles and Practices, Springer, ISBN 978-0-7923-6781-9.
2. Sasson A. Biotechnologies in developing countries present and future, UNESCO publishers,1993.
1. B.P.Pandey 2014. Economic Botany. S.Chand & Company Private Limited, Ram Nagar, New Delhi 110055.
2. Rashtra Vardhana.2009. Economic Botany. Sarup Book Publishers Pvt. Ltd, New Delhi -110002
3. Ramesh Umrani (2009). Basics of Economic Botany. Anmol Publications Pvt.Ltd, New Delhi – 110002.
4. Ashwini Dutt (2008). Economic Botany. Adhyayan Publishers & Distributors, New Delhi-110002.
5. K.V.Krishnamurthy (2003).An Advanced Text book on Biodiversity: Principles and Practice. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
6. Ganguli P (2001). *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.

7. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publishing House, New Delhi.

SEMESTER III (Theory): ELECTIVE PAPER-I

BOTPG-ET-303-1: PLANT SYSTEMATICS

Total Max. Marks-100 **Total Credit-04**

UNIT – I: APPROACHES TO PLANT SYSTEMATICS

Difference in Systematics and Taxonomy; Principles and procedures of plant systematics; Plant speciation: Allopatric, abrupt, sympatric, hybrid, apomictic speciation, Isolating mechanisms; Biosystematics: Steps in biosystematics, Biosystematic categories, Importance of Biosystematic studies.

UNIT-II: DEVELOPING CLASSIFICATION

Systems of Angiosperm Classification: Phenetic versus phylogenetic systems. Principles of Taxometriics. Cladistics in taxonomy-Phylogenetic terms; plesiomorphic and apomorphic characters; homology and analogy; parrellelism and convergence; monophyly, paraphyly, polyphyly; phylogenetic diagram; phylogenetic data analysis.

UNIT-III: VARIATION TYPES AND CAUSES

Types of variation; variance analysis; reproductive system-types; outbreeding; Hybridization-introgressive hybridization; recognition of hybrids; stabilization of hybrids; outbreeders with internal barriers; inbreeding. Evolution-mutation; random genetic drift; natural selection; Darwinian fitness and fitness coefficient; molecular evolution.

UNIT-IV: PHYLOGENY OF ANGIOSPERM

Origin of angiosperms; age of angiosperm; molecular dating. Monophyletic and polyphyletic origin of angiosperms; possible ancestor and theories; origin of monocot, basal living angiosperms. Evolutionary trends- evolution of inferior ovary.

SUGGESTED READINGS

1. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
3. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
4. Cronquist A (1981). An integrated system of classification of flowering plants. Columbia Evolution. Taylor and Francis, London.
5. Jain S.K. (1995). Manual of Ethnobotany. Scientific Publisher; Second edition (1995).
6. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002). Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
7. Nei M and Kumar S (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York.
8. Raven PH, Begr LR, Hassenzahl DM (2008). Environment. 6th edition. John Wiley & Sons, Inc., New York.
9. Semple C and Steel MA (2003). Phylogenetics. Oxford University Press, Oxford.
10. Simpson MG (2006). Plant Systematics. Elsevier, Amsterdam.

SEMESTER-III (Theory): ELECTIVE PAPER-I

BOTPG-ET-303-2: MICROBIOLOGY

Total Max. Marks-100 **Total Credit-04**

UNIT-I: FUNDAMENTALS OF MICROBIOLOGY 15 Hrs.

Early history, milestone discoveries and developmental aspects of microbiology. The study of Microbial Structure; Microscopy and Specimen Preparation. Prokaryotic cell structure and Eukaryotic cell structure. Properties and structure of viruses and viroid. Nutritional requirements and Nutritional types of bacteria.

UNIT –II: PATHOGENICITY AND CONTROL OF MICROORGANISMS 15 Hrs.

Host parasite relationship. Bacterial and viral pathogenesis. Toxigenecity, pathogenic types of toxins. Host defence against microbial invasion-non-specific and specific defense mechanisms. Control of microorganisms by physical agents, chemical agents, antibiotics and other chemotherapeutic agents.

UNIT-III: AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY 15 Hrs.

Microorganisms of soils, rhizospheres and phylloplane. Biological Nitrogen Fixation- symbiotic and asymbiotic, and Phosphate solubilizing bacteria. Biological control agent for plant disease control. Modern wastewater treatment (Primary, secondary and tertiary). Drinking water purification. The concept of indicator microorganisms (Total coliforms). Criteria for an ideal indicator organism. Biodegradation of xenobiotics- pesticide catabolism, reductive dechlorination, aerobic dechlorination.

UNIT-IV: FOOD AND INDUSTRIAL MICROBIOLOGY 15 Hrs.

Fermentation and fermentation techniques. Microbiology and production of (kinema, soysauce, Cheese, wine, beer, whisky, sausages, vitamins, antibiotics). Food preservation methods. Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies, HACCP. Probiotics: Definition, characteristic, Gut microbiota, beneficial effects of probiotic bacteria; prebiotics and synbiotics.

REFERENCES

1. R.P. Singh, (2005) Plant Pathology. Kalyani Publishers Ludhiana.
2. Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi Biotechnology. Oxford & IBH, New Delhi.
3. Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving
4. Fry WE. 1982. Principles of Plant Disease Management. Academic Press, New York
5. Hewitt HG. 1998. Fungicides in Crop Protection. CABI, Wallington.
6. Marsh RW. 1972. Systemic Fungicides. Longman, New York.
7. Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control. Oxford & IBH, New Delhi.
8. Palti J. 1981. Cultural Practices and Infectious Crop Diseases. Springer- Verlag, New York.
9. Vyas SC. 1993 Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

SEMESTER III (Theory): ELECTIVE PAPER-I

BOTPG-ET-303-3: GENE EXPRESSION AND GENETIC ENGINEERING

Total Max. Marks-100 **Total Credit-04**

UNIT-I: REGULATION OF GENE EXPRESSION 15 Hrs.

Regulation of gene expression in prokaryotes and Eukaryotes. Expression of *lac, trp* and *gal* operonS. Attenuation, Antitermination, Methylation, Yeast GAL regulatory pathway, alteration of gene expression by DNA sequence rearrangements, transcriptional regulation in Eukaryotes. .

UNIT-II: RECOMBINATION AND TRANSPOSABLE ELEMENTS 15 Hrs.

Bacterial Recombination: Homologous recombination, Generalized & Site1specific recombinations, Transposable elements, Genomic instability caused by Transposable elements, Bacterial Transposable elements, Eukaryotic Transposable elements, Biological significance of Recombination & Transposable elements.

UNIT-III: INTRODUCTION TO GENETIC ENGINEERING 15 Hrs.

An introduction to genetic engineering, Enzymes used in genetic engineering Restriction endonucleases, DNA polymerase, Reverse transcriptase, Polynucleotide kinase, DNA ligase, Terminal deoxynucleotidyl transferase, Alkaline phosphatase. Ligation of DNA fragments with vectors Homopolymer tailing, Linkers, Adaptors. Vectors for cloning - Plasmids, Bacteriophage λ, Filamentous phage vectors, cosmids, BAC and YAC vectors, Shuttle vectors, Expression vectors.

UNIT-IV: APPLICATIONS OF GENETIC ENGINEERING 15 Hrs.

Gene transfer techniques in plants. Application of genetic engineering, transgenic plants for insect, fungal, bacterial disease resistance, lignin, modification, abiotic stress tolerance, production of useful products, molecular farming.

REFERENCES

1. Desmond S T Nicholl. 2008. An Introduction to Genetic Engineering. Cambridge Univ. press, USA.
2. P S Verma and V K Agarwal. 2009.Genetic Engineering. S Chand & Company Ltd. New Delhi
3. Kurnaz I A.2015. Techniques in Genetic Engineering. CRC Press. Taylor & Francis Gp. USA
4. T A Brown. 2016. Gene Cloning and DNA analysis (2nd Edition), John Wiley & Sons Inc.,UK
5. J K Setlow. 2010. Genetic Engineering: Principles & Methods, Springer, Germany.
6. Lal R. and Lal S. 1993, Genetic engineering of plants for crop improvement. CRC Press.
7. Winkler, U. Ruger W. and Wackernagel W. 1979. Bacterial phage and molecular genetics.
8. Gustafson J. P. 1990 Gene manipulation in plant improvement I and II. Plenum Press, London.
9. Old R. W. and Primrose S. B. 1989 Principles of Gene Manipulation. Blackwell Scientific Publ Oxford UK.

SEMESTER III (Theory): ELECTIVE PAPER-I
BOTPG-ET-303-4: FUBDAMENTALS OF ECOLOGY

Total Max. Marks-100 **Total Credit-04**

UNIT I: ECOLOGY: AN INDIAN PERSPECTIVE

Ecology in India, Evolution of ecological thoughts, Ecologists of India, Environmental Issues of India. Environmental movements of India. India's initiatives for environmental problems.

UNIT II: POPULATION ECOLOGY AND SPECIES INTERACTIONS

Characteristics of populations, Population growth forms, Population regulation, r and k Selection strategies, species interaction types, Lotka-Voltera Model of competition,Theory of resource capture and sharing, Herbivores counter measures, Model of predator prey dynamics, parasitic vascular plants.

UNIT III: PRODUCTIVITY AND ECOLOGICAL SUCCESSION

Concept of primary production, Measurements of primary productivity, plant biomass and turnover, Litterfall in terrestrial ecosystems, food chain and food web, energy flow models, Secondary productivity, Ecological Succession types,Theories and Models of succession, climax concept, Changes involved in succession.

UNIT IV: VEGETATION SAMPLING METHODS AND DATA ANALYSIS

Sampling approaches, Releve method, quadrat method, line transect method, point frame method, and plotless method. Vegetation analysis –classification , species association.

REFERENCES:

1. Chapman, J.L.& M.J. Reiss. 1998. Ecology: Principles and Applicatiions. Cambridge Univ. press. 2nd edition. 336 pgs.
2. Krebs, C.J. 2008. Ecology: The experimental Analysis of Distribution and Abundance (6th Edition), Benjamin Cummings Publ. 688pgs.
3. Miller. G.T. 2004. Environmental Science. Thomson, California. 538 pgs.
4. Singh, J.S., Singh, S.P & Gupta, S.R. 2006. Ecology, Environment and Resource conservation. Anamaya Publ., New Delhi, 688 pp.
5. Begon, M. ; Harper, J.L. and Townsend, C.R. (2006). Ecology: individuals, populations and communities. Blackwell Scientific Publications.
6. Dash, M.C.and Dash,S.P. (2009). Fundamentals of ecology (3rd edition). Tata McGraw-Hill Publishing Co., New Delhi.

SEMESTER III (Theory): ELECTIVE PAPER-I

BOTPG-ET-303-5: ADVANCED PLANT PHYSIOLOGY

Total Max. Marks-100 **Total Credit-04**

UNIT-I: PLANT GROWTH REGULATORS **12 Hrs.**

Concept of hormones as chemical messenger; Physiological effects and mechanism of action of brassinosteroids, jasmonic acid and salicylic acid; Role of hormones in defense against biotic and abiotic stress; synthetic regulatory compounds and their uses.

UNIT-II: PROGRAMMED CELL DEATH (PCD) AND SENESCENCE **15 Hrs**

Programmed Cell Death: Basic concepts; types of cell death, Programmed Cell Death in Plants; Aerenchyma formation and HR; Reactive oxygen species and PCD; Apoptosis and PCD;

Senescence: Introduction to senescence; Metabolic changes associated with senescence and its regulations; Pigment breakdown during senescence Nucleic acid degradation during senescence; Protein metabolism during senescence.

UNIT-III: REPRODUCTIVE PHYSIOLOGY **15 Hrs.**

Flowering: floral induction, evocation and morphogenesis, ABC model of flowering, manipulation of flowering and floriculture. Fruit ripening: physiology of ripening, biochemical changes during ripening; Deposition of reserves during seed development; Germination: metabolic changes during seed germination

UNIT-IV: STRESS PHYSIOLOGY **15Hrs.**

Plant responses to abiotic stresses; Water deficit and its physiological consequences; Osmotic adjustment in response to drought and salinity; Drought tolerance mechanisms; Salinity stress and plant responses; Heat stress and low temperature stress, antioxidant mechanisms.

SUGGESTED READING:

1. Buchanan B.B, Gruissem W. and Jones R.L 2007. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologistsm Maryland, USA.
2. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA.
3. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
4. Taiz L. and Zeiger E. 2010. Plant Physiology (5th Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.
5. Barrett SCH (2008) Major Evolutionary Transitions in Flowering Plant Reproduction. Univ.of Chicago Press.
6. Harder LD & Barrett SCH (2006) Ecology and Evolution of Flowers, Oxford Univ. Press.
7. Shivanna KR (2003) Pollen Biology and Biotechnology. Enfield, New Hampshire, U.S.A., Science Publishers.

SEMESTER III (Theory): ELECTIVE PAPER-I

BOTPG-ET-303-6: ETHNOBIOLOGY AND ETHNOPHARMACOLOGY

Total Max. Marks-100 **Total Credit-04**

UNIT- I ETHNOBOTANY 15 Hrs.

Ethnobotany: concept, history, evolution and scope; Indigenous knowledge and traditional practices of some Himalayan communities; Taxonomic epidermal characters and pharmacognostical studies to check adulteration. Problems and prospects of value addition applicable to plant resources. Scope for development of plant resources.

UNIT II: ETHNOBIOLOGY OF NORTH EAST INDIA 15 Hrs.

Major ethnic group in North East India India, their social institutions, livelihood, cultural and religious practices Shamanism and other belief systems, sacred groove and methods of biological resource conservation. Current status of Ethnobiolgoy; Ethnobiology, biodiversity and traditional knowledge;

UNIT- III ETHNOPHARMACOLGY 15 Hrs.

Role of Ethnobotany in drug discovery. Ayurvedic drug preparation and drug adulteration. Chemical composition of few medicinal and aromatic plants, extraction and uses pertaining to typical Indian formulation of drugs. Ethnopharmacological validation of traditional medicine; approaches to drug discovery from ethnobotanical leads.

UNIT- IV NATURAL PRODUCTS FROM PLANTS 15 Hrs.

Definition, importance and systematics and characterization of Natural products. Phenolic acids, alkaloids, glycosides, terpenoids, flavonoids, steroids, tannins in plants kingdom. Function of secondary metabolite for plant defense and protection.

REFERENCES:

1. Cotton, C.M. (1997). Ethnobotany – Principles and applications. John Wiley and Sons – Chichester.
2. Das, T.S. (1986). Tribal life of North - Eastern India. Gian Publishing House.
3. Das, A.P. and Pandey, A.K. (2007). Advances in Ethnobotany. Bishen Singh and Mahendra Pal Singh, Dehradun.
4. Dhar, U. (1993). Himalayan Biodiversity: Conservation Strategies. Gyanodaya Prakashan.
5. Jain, S.K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur.
6. Jain, S.K. (1990). Contributions of Indian Ethnobotany. Scientific publishers, Jodhpur.
7. Subba, T. B. and Ghosh , G. C. (2003). Anthropology of North-East India. Orient Longman Limited, New Delhi.

SEMESTER III (Practical): ELECTIVE PAPER-II

BOTPG-EP-304-1: TAXONOMY LAB

Total Max. Marks-100 **Total Credit-04**

1. Live plants/ Herbarium specimens of the following families will be provided in the class for description and identification (classification based on APG II, 2003):
2. Basal Angiosperm and Magnoliids: Nymphaeaceae, Magnoliaceae
3. Basal Monocots: Araceae, Alismataceae
4. Petaloid monocots: Liliaceae, Smilacaceae, Alliaceae, Orchidaceae
5. Commelinids: Commelinaceae, Poaceae, Cyperaceae
6. Basal Eudicots and Caryophyllids: Ranunculaceae, Caryophyllaceae
7. Rosids: Euphorbiaceae, Rosaceae, Fabaceae, Cucurbitaceae
8. Asterids: Solanaceae, Lamiaceae, Apiaceae, Asteraceae
9. Writing exercise
10. Nomenclature exercise
11. Classification exercise
12. Cladogram construction and analysis

SUGGESTED READINGS

1. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
3. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
4. Cronquist A (1981). An integrated system of classification of flowering plants. Columbia
5. Evolution. Taylor and Francis, London.
6. Jain S.K. (1995). Manual of Ethnobotany. Scientific Publisher; Second edition (1995).
7. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002). Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
8. Nei M and Kumar S (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York.
9. Raven PH, Begr LR, Hassenzahl DM (2008). Environment. 6th edition. John Wiley & Sons, Inc., New York.
10. Semple C and Steel MA (2003). Phylogenetics. Oxford University Press, Oxford.

SEMESTER-III (Practical): ELECTIVE PAPER-II

BOTPG-ET-304-2: MICROBIOLOGY LAB

Total Max. Marks-100 **Total Credit-04**

1. Laboratory Rules, tools, equipments and other requirements in microbiological laboratory.
2. Microscopy and Micrometry.
3. Preparation of culture media and methods of sterilization.
4. Maintenance of pure cultures.
5. Isolation of microorganisms by pour plate/serial dilution method.
6 . Identification of bacteria by biochemical methods
7. Bacterial staining: Acid fast staining of bacteria, Bacterial cell wall staining, Cytoplasmic membrane staining, Capsule staining.
8. Isolation of food poisoning bacteria from contaminated foods, Dairy products.
9. Preservation of industrially important bacteria by lyophilization.
10. Determination of gas, acid production by the bacteria during fermentation.
11. Determination of hydrolysis starch, fat, protein.
12. Antibiotic susceptibility

REFERENCES

1. Harrigan, W.F. 1998. Laboratory Methods in Food Microbiology. 3 rd edition. Academic Press, London.
2. Roberts, D. and Greenwood, M. 2002. Practical Food Microbiology. 3 rd edition, WileyBlackwell.
4. Hurst, C. J., Crawford, R. L., Knudsen, G. R., McInerey, M. J. and Stetzenbach, L. D. 2002. Manual of Environmental Microbiology, Second edition. ASM Press, Washington DC.
5. Cappuccino, J. G. and Sherman, N. 2007. Microbiology- A Laboratory Manual, Seventh Edition, Pearson Education, Inc. and Dorling Kindersley (Indi) Pvt Ltd, Delhi, India.

5 Aneja, K.R. 1996. Experiments in Microbiology, plant pathology and tissue culture.

SEMESTER III (Practical): ELECTIVE PAPER-II

BOTPG-ET-304-3: MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

Total Max. Marks-100 **Total Credit-04**

1. Isolation of Plasmid DNA (Ti Plasmid) from *E.coli* cells.
2. Isolation of plant DNA from leaf tissue.
3. Isolation of RNA from leaf tissue.
4. Isolation of total proteins from seed sample.
5. Agarose gel electrophoresis for separation of DNA.
6. Purity checking and Quantification of nucleic acids.
7. SDS-PAGE for separation of protein mixtures.
8. Restriction digestion.
9. Polymerase Chain Reaction and DNA amplification.
10. Transformation of *E.coli.*
11. Southern hybridization.
12. Western blotting.

References:

1. Mitra Sandhya 1996, Genetic Engineering Macmillan India Ltd.
2. Lal R. and Lal S. 1993, Genetic engineering of plants for crop improvement. CRC Press.
3. Winkler, U. Ruger W. and Wackernagel W. 1979. Bacterial phage and molecular genetics. Narosa Publication New Delhi.
4. Gustafson J. P. 1990 Gene manipulation in plant improvement I and II. Plenum Press London.
5. Old R. W. and Primrose S. B. 1989 Principles of Gene Manipulation. Blackwell Scientific Publ Oxford UK.
6. Razdan M. K. and Cocking E. C. 2000 Conservation of plant genetic recourses in vitro.Oxford and IBH publishing Co. Pvt. Ltd.
7. Razdan M. K. and Bhojwani S. S. 1996, Plant tissue culture: Theory and practice a revised edition. Elsevier Science.
8. Trigiano R. N. and Gray D. J. 2000 Plant tissue culture concepts and laboratory exercises. CRS press LLC.
9. Gustafson J. P. 2000 Genomes. Kluwer Academic Plenum Publishers New York USA.
10. Brown T. A. 1999 Genomes. John Wiley and Sons Pvt. Ltd. Singapore.

SEMESTER III (Practical): ELECTIVE PAPER-II

BOTPG-ET304-4: ECOLOGY LAB

100 Marks **Total credits-04**

1. Determination of leaf area Index (LAI)
2. Determination of Water holding capacity of soil
3. Preparation of Raunkiar's normal frequency diagram
4. Determination of minimum size of quadrat by species area curve
5. Studies of physico - chemical properties of soil
   (a) Texture (b) Porosity (c) Water holding capacity (d) organic matter content
6. Determination of primary productivity by harvest method in grassland
7. To calculate the concentration of dominance (cd) of different species.
8. To calculate diversity index of different species.
9. To evaluate the importance value Index (IVI) of different species.
10. Determination and categorization of forest floor litter mass.
11. Study of soil profile in a forest.
12. Study of clump characteristics of bamboo

REFERENCES:

1. Brewer, R. and McCann, M.T. (1982). Laboratory and field manual of ecology, Saunders College Publishing.
2. Michael, P. (1984).Ecological methods for field and laboratory investigation. Tata McGraw-Hill, New Delhi.
3. Moore, P.D. and Chapman, S.B. (1986). Methods in plant ecology. Blackwell Scientific Publications.
4. Misra, R. (1968).Ecology work book, Oxford and IBH Publishing Co. Calcutta.
5. Mueller-Dombois, D and Ellenberg, H. (1974). Aims and methods of vegetation ecology. John Wiley and Sons, New York

SEMESTER III (Practical): ELECTIVE PAPER-II

BOTPG-ET-304-5: PLANT PHYSIOLOGY LAB

Total Max. Marks-100 **Total Credit-04**

1. Determination of Osmotic pressure of plant tissue
2. Estimation of total Chlorophyll from leaves of different chronological ages
3. Study on Seed viability by Tetrazolium test [TZ] test
4. Preparation of standard curve of a known protein (Bovine Serum Albumin) and estimation of an unknown protein by Lowry's method
5. Extraction and estimation of Peroxidase from plant sample.
6. Extraction and estimation of free amino acid from plant sample
7. PAGE for separation of Protein mixtures.
8. Determination of the absorption spectrum of chlorophylls
9. Determination of free amino acids from plant sample with paper chromatography or TLC
10. Determination of sugars in germinating seeds by TLC
11. Analysis of proline in normal and water stressed or salt stressed plants
12. Study of α- amylase activity in germinating seeds and

REFERENCES:

1. Sadasivam S and Manickam A. 2010. Biochemical methods, New Age International Publishers, New Delhi
2. Bewly JD and Black E. 1980. Seeds: physiology of development and germination. Plenum Publishing Corporation.
3. Darwin Fand Hamilton Acton E. 2011. Practical Physiology of Plants (Reissue edition), Cambridge University Press, Cambridge, UK
4. MacDougal DT. 2009. Practical Text-Book of Plant Physiology, University of Michigan Library, Michigan, USA
5. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.

SEMESTER III (Practical): ELECTIVE PAPER-II

BOTPG-ET-304-6: CRUDE DRUG ANALYSIS LAB

Total Max. Marks-100 **Total Credit-04**

1. Study of powdered drugs – physical, chemical and microscopic examinations.
2. Quantitative microscopy of leaf drug – stomatal frequency and stomatal index,
3. Determination of palisade ratio and vein islet number.
4. Qualitative determination of alkaloids, tannins, steroids and saponins from medicinal plants
5. Determination of water soluble and water insoluble ash from crude drugs.
6. Determination of foaming index from crude drugs
7. Determination of titratable organic acid from leaves and fruits
8. Determination of ascorbic acid from plant sample
9. Estimation of phytic acid
10. Determination of total phenol content from powdered drugs.
11. Determination of free radical scavenging activity of methanolic extracts of powdered drugs.
12. Quantitative estimation of total flavanols content of drugs.

REFERENCES

1. Bajracharya D. (1998). Experiments in Plant Physiology, Narosa Publishing House, New Delhi.
2. Bhattacharya A and Vijay Laxmi (2015). Methods and techniques in plant physiology, New India Publishing Agency, New Delhi
3. Mandal S.C., Mandal V and Das A. K. (2015), Essentials of Botanical Extraction, Academic Press, London
4. Evans W. C. (2009). Trease and Evans Pharmacognosy, Saunders Elsevier, Edinburgh

SEMESTER-IV

SEMESTER-IV (Theory): ELECTIVE PAPER-III

BOTPG-ET-401-1: MODERN TRENDS IN SYSTEMATICS

Total Max. Marks-100 **Total Credit-04**

UNIT-I- CHEMO AND CYTOTAXONOMY

Cytotaxonomy: Chromosome number, basic chromosome number, polyploidy, aneuploidy, chromosome morphology, karyotype, chromosome banding, meiotic analysis, scope and limitations.
Chemotaxonomy: Origin of chemotaxonomy, classes of compounds and their biological significance, stages in chemotaxonomic investigations; techniques, use of chemical criteria in plant taxonomy.

UNIT-II-NUMERICAL TAXONOMY AND PALYNOLOGY

Numerical Taxonomy: Principles, construction of taxonomic groups, OUTs, unit characters, character coding, measurement of resemblances, cluster analysis, phenons and ranks, discrimination, nomenclature and numerical taxonomy, merits and demerits.
Palyotaxonomy: Pollen morphology-Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern, palynogram; pollen characters of taxonomic importance.

UNIT-III: EMBRYOLOGY AND ANATOMY

Embryology in relation to taxonomy: Embryological characters of taxonomic importance, utilization of embryological data in solving taxonomic problems.
Anatomy in relation to taxonomy: Vegetative, wood and floral anatomy, anatomical characters of taxonomic importance, use of anatomical data in understanding interrelationship and evolution of angiosperms and solving taxonomic problems.

UNIT-IV: MOLECULAR SYSTEMATICS

Introduction to molecular systematics; Generating molecular data, types of molecular data, conserved genes for taxonomic analyses – Nuclear, Plastid and mitochondrial genes; molecular characters; homoplasy, phylogeny reconstruction, methods of estimating genetic diversity using molecular data and its modifications. Applications of molecular systematics in plant taxonomy.

REFERENCES

1. Angiosperm Phylogeny Group 2003. An update of the Angiosperm Phylogeny Group
2. Crawford, D.J. 2003. Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
3. Judd, W.S., C.S. Campbell, E.A. Kellogg, P.F.Stevens and M.J. Donoghue 2002. Plant Systematics: A phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
4. Nei, M. and S. Kumar 2000. Molecular Evolution and Phylogenetics. Oxford University Press, New York.
5. Semple, C. and M.A. Steel 2003. Phylogenetics. Oxford University Press, Oxford.
6. Michael,G. Simpson. Plant Systematics. 2006. Elsevier Academic Press, Burlington, MA.
7. Gurcharan Singh, Plant Systematics, (2 ed.), 2004. Ox. & IBH Publ. Co, Pvt. Ltd., New Delhi.
8. Hillis, D.M., Mortiz,C. & Mable, B.K. (eds.) 1996, Mol. Systematics, Sinaver Associates, Sunderland, USA.
9. Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC, Publishers, Sunderland, Massachusetts, USA.

SEMESTER IV (Theory): ELECTIVE PAPER-III
BOTPG-ET-401-2: PLANT DISEASES AND PROTECTION

Total Max. Marks-100 **Total Credit-04**

UNIT –I: PATHOGENS AND DISEASES 15 Hrs.

Plant diseases and pathogens, mode of infection, Role of enzymes and toxins in Plant diseases. Koch's postulates. Disease cycle. Defense mechanisms of plant diseases against infection. Structural defense and biochemical defense. Enzymes and toxins in plant disease.

UNIT-II: DISEASE FORECASTING AND EPIDEMICS 15 Hrs.

Disease diagnosis and assessment, Plant disease epidemics, Disease forecasting and its importance. Methods used in diseases forecasting. Dispersal of plant pathogens. Effect of environmental factors in disease development. Molecular methods for detection of plant pathogens.

UNIT-III: STUDY OF IMPORTANT PLANT DISEASES: 15 Hrs.

Study of Plant diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma like organisms: Fungal: Wart disease of potato, Rhizome rot of ginger, blight of *Colocasia*, Smut of maize. Bacterial: Wilt and brown rot of potato, Citrus greening, Blight disease if rice, wilt disease of maize. Viral: Chirkey and foorkey disease of large cardamom, *Potato spindle tuber viroid* (PSTVd), Leaf curl of tomato. Nematodes: Citrus nematode, Root knot of vegetables. Mycoplasmas: Grassy shoot disease (GSD) of sugarcane, Little leaf of brinjal, coconut root wilt.

UNIT-III: MANAGEMENT OF PLANT DISEASES 15 Hrs.

Cultural methods, Chemical methods. Breeding for disease resistance, types of resistance. Methods of Selection of resistant genotypes. Breeding wheat for disease resistance, Breeding rice for resistance, breeding sugarcane for resistance, breeding potato for resistance. Innovative methods of plant disease control.

REFERENCES

1. Agrios, G.N. (1997). Plant Pathology. Academic Press, New York.
2. Ainsworth, G.C. Sparrow, F.K., and Sussman A.S. (1973). The Fungi- An Advanced Treatise.Vols. IV A. Academic Press, London.
3. Mehrotra, R.S. (1980). Plant Pathology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Mehrotra, R.S. and Aneja, K.R. (1990). An Introduction to Mycology. New Age International Publishers, New Delhi.
5. Webster, J. (1980). Introduction to Fungi. Cambridge University Press, Cambridge, London.
6. Vashista, B.R. and Sinha, A.K. (2008) Botany for degree students-Fungi. S. Chand and Company Ltd, New Delhi-pp 1-752.

SEMESTER-IV (Theory): ELECTIVE PAPER-III

BOTPG-ET-401-3: GENOMICS AND PROTEOMICS

Total Max. Marks-100 **Total Credit-04**

UNIT-I- GENOME ORGANIZATION 15 Hrs.

Important features of bacterial and eukaryotic genome organization. Organellar genome: Mitochondiria and Chloroplast genome. C-Value Paradox. Plant Genome Analysis: Classes of molecular markers & applications, genetic and physical mapping.

UNIT-II- GENOME SEQUENCING 15 Hrs.

Strategies for genome sequencing: Chain termination method, automated sequencing, pyro-sequencing. Sequence assembly: Next Generation Sequencing (NGS) methods, data analysis, bioinformatics tools. Plant genome project and its applications. Applications of DNA sequencing to crop improvement.

UNIT-III- FUNCTIONAL GENOMICS 15 Hrs.

Determination of the functions of genes: gene inactivation (knock-out, anti-sense and RNA interference) and gene over expression. Approaches to analyze global gene expression: transcriptome, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (ESTs), Massively Parallel Signature Sequencing (MPSS), microarray and its applications, gene tagging, Metagenomics. Genome editing-CRISPR-cas9 system.

UNIT-III- PROTEOMICS 15 Hrs.

Introduction and scope of proteomics; Protein extraction, separation, detection and quantification methods. Protein sequencing and modification. Protein-protein interaction (Two hybrid interaction screening); Protein engineering; Protein chips and functional proteomics. Application of proteomics to plant sciences; Proteome database; Proteomics industry.

REFERENCES

1. JD Wale, 2002. From Genes to Genomes: Concepts and Applications of DNA Technology. Wiley-Blackwell Publishers.
2. Primrose and Twyman. 2002. Principles of Genome Analysis and Genomics. Blackwell publishing, USA. R.M.Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.
3. P.Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa,New Jersay, USA, 2003.
4. De Robertis and De Robertis, 1990, Cell and Molecular Biol., Saunders College, Philadelphia, USA
5. Weaver, R.F. and Hedrick,P.W., 1989, Genetics. Wm, C. Brown Pub, Dubuque.

SEMESTER IV (Theory): ELECTIVE PAPER-III

BOT-PG-CT-401(4): COMMUNITY ECOLOGY AND CLIMATE CHANGE

Total Max.Mark-100 **Total credits-04**

UNIT-I: ECOSYSTEM ECOLOGY

Ecosystem structure-Biotic and Abiotic component, Ecosystem functions, Ecosystem Processes- Respiration, Decomposition, Nature of plant community-Discrete View, Continuum view and synthetic approach, community structure and attributes, Keystone species

UNIT-II: NATURAL RESOURCES AND PLANT ADAPTATIONS

Types of natural resources, Human impact on natural resources and mangement, Energy resources, Mineral Resources, Law of tolerance, Ecotypes, Ecoclines, Acclimation, Plant adaptations Strategies.

UNIT-III: NUTRIENT CYCLING AND BIOGEOCHEMICAL CYCLING

Nutrient cycling models, Nutrients inputs and outputs to ecosystem, Storage and Accumulation of nutrients in plants, Intersystem and Intrasystem nutrient cycling, Biogeochemical cycling - C, N, P and S cycle.

UNIT-IV: GLOBAL ENVIRONMENTAL CHANGE AND ENVIRONMENTAL POLLUTION

Green house gas effect, Global warming and its effects of environment, Tools to study global climate change and strategies of mitigation, Ozone layer depletion and means of Protection, Global and Indian initiatives to mitigate climate change. Air, water, soil and noise pollution, Ecotoxicants: distribution and fate of toxic substance, Toxic effect from individuals to ecosystem.

REFERENCES:

1. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publ., New Delhi. 688Pp.
2. Climate Change and Biodiversity; By Thomas E. Lovejoy, Lee Jay Hannah Published by Yale University Press, 2006 ISBN 0300119801, 80300119800 418 pages
3. William H. Schlesinger. 1997. Biogeochemistry: An Analysis of Global Change. Academic Press, San Diego, CA. 2nd edition. Available at the Bay Tree Bookstore.
4. Global Environmental Change: Research Pathways for the Next Decade, National Research Council, 1999
5. M. C. Jacobson, R. J. Charlson, H. Rodhe, and G. H. Orians. 2002. Earth System Science: From Biogeochemical Cycles to Global Change. Academic Press, San Diego, CA.
6. 5.Our Common Journey: A Transition Toward Sustainability, National Research Council, 1999

SEMESTER-IV (Theory): ELECTIVE PAPER-III

BOTPG-ET-401-5: PLANT METABOLISM

Total Max. Marks-100 **Total Credit-04**

UNIT-I: CARBOHYDRATE METABOLISM **15Hrs**

Gluconeogenesis; Stoichiometry and energy balance of gluconeogenesis; Regulation of gluconeogenesis;; Glycogen biosynthesis; Catabolism of polysaccharides; Pentose phosphate pathway. Sucrose biosynthesis and degradation, role of Fructose 2,6-bisphosphate in carbohydrate metabolism, starch synthesis and degradation.

UNIT-II: LIPID METABOLISM **15Hrs**

Biosynthesis of fatty acids; Oxidation of lipids: β, α and ω oxidation of fatty acids; Stoichiometry of β-oxidation; Triacylglycerol synthesis; Metabolism of cholesterol and its regulation; Glycerolipid biosynthesis; Role of lipids in signaling and defence.

UNIT-III: AMINO ACID METABOLISM **15Hrs**

Classification of amino acids; General reactions of amino acid metabolism; Biosynthesis of aromatic amino acids; Amino acid proline and stress response; Glutathione: metabolism and function; Amino acid degradation; Urea cycle and its regulation; Catabolism of amino acids; Metabolic defects in amino acid metabolism.

Unit-IV: SECONDARY METABOLITES **15Hrs**

Secondary metabolites: introduction and functions; Basic metabolic pathway and the origin of secondary metabolites; Biosynthesis of to phenolics; Alkaloids: Nomenclature, classification and uses; Biosynthesis of alkaloids; biosynthesis of terpenoids; General account of flavonoids; Plant defenses against pathogens; Metabolic engineering in the production of pharmaceuticals; Bioprospecting for naturally derived anticancer agents, metabolomics

REFERENCES

1. Voet and Voet, 1992. **Biochemistry**, John Wiley & Sons, Inc., New York, USA.
2. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H.Freeman and Company, New York, USA
3. Bowsher et al., 2008. Plant Biochemistry, Garland Science, New York
4. Mathews, Van Holde and Ahern. 2007,Biochemistry (3rd Ed), Pearson Edsucation, Delhi
5. Dey PM and Harborne JR. 2000, Plant Biochemistry, Harcourt Asia Pvt. Ltd., Singapore
6. Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.

SEMESTER-IV (Theory): ELECTIVE PAPER-III

BOTPG-ET-401-6: HERBAL MEDICINE AND EASTERN HIMALAYAN BIORESOURCES

Total Max. Marks-100 **Total Credit-04**

UNIT- I HERBAL MEDICINE 15 Hrs.

Medicinal plant research scenario in India; Diagnostic features, bioactive molecules and therapeutic value of some common medicinal plants; Standardisation of herbal drugs; Commercial cultivation of medicinal plants; Conservation of medicinal plants; Neutraceuticals and medicinal food

UNIT- II CHEMISTRY AND PHARMACOLOGY OF HERBAL DRUGS 15 Hrs.

Classification of active plant constituents with source and phytotherapeutic properties; Routes of drug administration; Absorption, metabolism and fate of drugs; Mechanism of drug action; Drug tolerance. Metabolic pathways of some important secondary metabolites.

UNIT- III EASTERN HIMALAYAN BIORESOURCES 15 Hrs.

Definition and demarcation of the Eastern Himalayas. Geographical background of Eastern Himalayas. Biodiversity hotspot zones and sub classification Bio-resources of Eastern Himalayas: medicinal and aromatic plants, wild edible plants spices and condiments, beverages, masticatories, important timber yielding and fire wood plants, important Non-Timber Forest Products (NTFP's), ethno-veterinary plants, bamboos, raw material for paper, gum, resin, tannins and dyes.

UNIT- IV CONSERVATION BIOLOGY 15 Hrs.

Current practice in conservation in India and abroad. Organisations involved in resource conservation; Phytogeography – Hotspots of India and world. Strategies for *in situ* and *ex-situ* conservation – Protected areas, Wildlife sanctuaries, National parks, Biosphere reserves.

REFERENCES:

1. Cotton, C.M. (1997). Ethnobotany – Principles and applications. John Wiley and Sons – Chichester.
2. Das, A.P. and Pandey, A.K. (2007). Advances in Ethnobotany. Bishen Singh and Mahendra Pal Singh, Dehradun.
3. Dhar, U. (1993). Himalayan Biodiversity: Conservation Strategies. Gyanodaya Prakashan.
4. Pusphanganthan *et al*. (1997).Conservation and Ecological Economics of Biodiversity.
5. Simpson, B.B. and Conner - Ogorzaly, M. (1986). Economic Botany: plants of our world. Mc Graw Hill.
6. Subba, T. B. and Ghosh , G. C. (2003). Antropology of North-East India. Orient Longman Limited, New Delhi.

SEMESTER-IV (Theory): ELECTIVE PAPER-IV

BOTPG-ET-402-1: BIODIVERSITY CONSERVATION AND RESTORATION ECOLOGY

Total Max. Marks-100 **Total Credit-04**

UNIT-I: BIODIVERSITY CONSERVATION

Introduction and levels of biodiversity; biodiversity hotspots; Biodiversity threats-habitat loss and over exploitation of resources, invasive species. Biodiversity conservation-*in-situ* and *ex-situ*, sacred grooves, JFM, Concept of Lead Botanical Gardens and Biodiversity Parks, role of Botanical Gardens in plant conservation; IUCN threat categorization, extinction of species; biodiversity –ecosystem services; Biodiversity Act 2002.

UNIT-II: ECOLOGICAL RESTORATION AND EIA

Ecosystem degradation, concept and strategies of ecorestoration; Biological and biotechnological tools of ecorestoration; restoration of degraded ecosystems. EIA-purpose, aims, principles, EIA process and community involvement.

UNIT-III: REMOTE SENSING AND GIS

Process of remote sensing; remote sensing satellites; microwave remote sensing; data analysis and image processing; application of remote sensing; basic of GIS, tools of GIS, GIS data management. Application of GIS in ecology

UNIT –IV: SUSTAINABLE DEVELOPMENT AND ECOLOGICAL ECONOMICS

Definition and dimensions of sustainability; ecological footprint and carrying capacity. Threat to sustainbale development; indicators of sustainability; environmental sustainability index; ecological footprints; ecological economics; characteristics and role of Government and NGOs in sustainable development.

Suggested Readings:

1. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition)
2. Raven PH, Begr LR, Hassenzahl DM (2008) Environment. 6th edition. John Wiley & Sons, Inc., New York.
3. Gliesmann, S.R. (2006). Agroecology: The Ecology of Sustainable Food Systems. Technology & Engineering.
4. Gliesmann, S.R. (2006). Field and Laboratory Investigations in Agroecology. Technology & Engineering.
5. Paul A. Wojtkowski, P.A. (2004). Landscape agroecology, Haworth Press, Inc., New York. 330 pp.
6. Environmental Biotechnology - Theory and Application – M. H. Fulekar: CRC Press and Science Publisher, USA
7. M. H. Fulekar (2005) Environmental Biotechnology Oxford IBH Publishing cooperation.
8. Environmental Biotechnology-Alan Scragg,Oxford University Press. 6. Environmental Biotechnology, A BiosystemsApproach, Author(s):Daniel A. Vallero, PhD, ISBN: 978-0-12-375089-1,Copyright © 2010 Elsevier
9. Bruce Rittman, Perry L. McCarty (2000). Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000. Environmental Biotechnology: Basic Concepts and Applications. 2006, Indu Shekhar Thakur, I. K. International Pvt Ltd.
10. Ecosystem services: Charting a path to sustainability. National Academies Press (20 April 2012).

SEMESTER-IV (Theory): ELECTIVE PAPER-IV

BOTPG-ET-402-2: CROP PROTECTION AND MANAGEMENT

Total Max. Marks-100 **Total Credit-04**

UNIT-I: PRICIPLES OF DISEASE MANAGEMENT 15 Hrs.

Disease avoidance, Pathogen exclusion, Eradication of pathogen, Resitance to pathogen, Plant protectants (Fungicides, bactericides, pesticides and herbicides). Biological pest control and diseases, Storage pest and diseases.

UNIT –II: PLANT DISEASE CONTROL 15 Hrs.

Cultural, chemical, biological plant disease management, biopesticides, breeding for resistant varieties, Plant quarantine, integrated pest management.

UNIT-III: PLANT DISEASE MANAGEMENT 15 Hrs.

Screening of genetic disease resistance germplasm. Exploitation of pre penetration and penetration events, enhancing plant tolerance, resistance mechanism. Fungicide resistance.

UNIT-IV: MODERN ASPECTS OF PHYTOPATHOLOGY 15 Hrs.

Application of plant biotechnology in plant pathology. Uses of modern biotechnological tools in crop management. Testing for host resistance to diseases. Development of transgenic plants for disease resistance. Molecular breeding for disease resistance.

REFERENCES

1. R.P. Singh, (2005) Plant Pathology. Kalyani Publishers Ludhiana.
2. Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi Biotechnology. Oxford & IBH, New Delhi.
3. Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving
4. Fry WE. 1982. Principles of Plant Disease Management. Academic Press, New York
5. Hewitt HG. 1998. Fungicides in Crop Protection. CABI, Wallington.
6. Marsh RW. 1972. Systemic Fungicides. Longman, New York.
7. Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control. Oxford & IBH, New Delhi.
8. Palti J. 1981. Cultural Practices and Infectious Crop Diseases. Springer- Verlag, New York.
9. Vyas SC. 1993 Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

SEMESTER-IV (Theory): ELECTIVE PAPER-IV

BOTPG-ET-402-3 PLANT TISSUE CULTURE: TECHNIQUES & APPLICATIONS

Total Max. Marks-100 **Total Credit-04**

UNIT-I: INTRODUCTION TO PLANT TISSUE CUTLURE

Introduction to Plant Tissue culture, Terms and definitions, Historical background, Laboratory organization, Tools and techniques, methods of sterilization. Laboratory contaminants- it's control and measures.

UNIT-II: MEDIA AND CULTURE PREPARATION

Role of Micro and macro nutrients, Vitamins and carbon source in tissue culture, Media preparation-pH, Temperature, Solidifying agents, Slant Preparations etc. Maintenance of cultures, Environmental Conditions, explants characteristics. Explants selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2.

UNIT III: MICROPROPAGATION METHODS

Induction and growth parameters; Culture initiation, Callus culture. Micropropagation through various explants (Leaf, Stem, Axillary bud, Tuber, Corms and Bulbills), Somatic embryogenesis, Applications of micropropagation. Haploid production through anther and ovary culture. Endosperm culture.

UNIT IV: PLANT TISSUE CUTLURE IN CROP IMPROVEMENT

Crop improvement by in vitro techniques. Techniques and significance of Androgensis and Gynogenesis (ovary, ovule, egg, synergids culture). Protoplast culture and applications. Somatic hybridization. Somaclonal variation. Production of disease resistant, stress resistant and other mutants for agronomic characters and for efficient nutrient utilization. Advantages and limitations. Molecular farming.

References:

1. Butcher, D.n and D.S. Ingram,1982. Plant tissue culture. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Butenko, R.G, 1985. Plant cell culture. MIR Publishers, Moscow.
3. Dixon, R.A, 1985. Plant cell cultureA practical approach. IRL press Oxford, London. —
4. Dodds. J.H and L.N. Roberrtis (1985) Experiments in plant tissue culture, Cambridge University Press New York. –
5. Kalyan Kumar D.E.1992. Plant tissue culture, Agrobios, New Delhi.
6. Lindsley,K. 1992.Plant tissue culture manual. Kluwer Academic publishers.
7. Narayanaswamy, S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing company,Ltd. New Delhi.
8. Purohit, S.S and S.K. Mathur, 1993. Fundamentals of Biotechnology. Agrobotanical publishers, India.

SEMESTER-IV (Theory): *ELECTIVE PAPER*

BOTPG-ET 402-4: BIODIVERSITY CONSERVATION AND RESTORATION ECOLOGY

Total marks-100 **Total credits-04**

UNIT-I: BIODIVERSITY CONSERVATION

Introduction and levels of biodiversity; biodiversity hotspots; Biodiversity threats-habitat loss and over exploitation of resources, invasive species. Biodiversity conservation-*in-situ* and *ex-situ*, sacred grooves, JFM, Concept of Lead Botanical Gardens and Biodiversity Parks, role of Botanical Gardens in plant conservation; IUCN threat categorization, extinction of species; biodiversity –ecosystem services; Biodiversity Act 2002.

UNIT-II: ECOLOGICAL RESTORATION AND EIA

Ecosystem degradation, concept and strategies of ecorestoration; Biological and biotechnological tools of ecorestoration; restoration of degraded ecosystems. EIA-purpose, aims, principles, EIA process and community involvement.

UNIT-III: REMOTE SENSING AND GIS

Process of remote sensing; remote sensing satellites; microwave remote sensing; data analysis and image processing; application of remote sensing; basic of GIS, tools of GIS, GIS data management. Application of GIS in ecology

UNIT –IV: SUSTAINABLE DEVELOPMENT AND ECOLOGICAL ECONOMICS

Definition and dimensions of sustainability; ecological footprint and carrying capacity. Threat to sustainbale development; indicators of sustainability; environmental sustainability index; ecological footprints; ecological economics; characteristics and role of Government and NGOs in sustainable development.

Suggested Readings:

1. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton,
2. USA (Special Indian Edition)
3. Raven PH, Begr LR, Hassenzahl DM (2008) Environment. 6th edition. John Wiley & Sons, Inc., New York.
4. Gliesmann, S.R. (2006). Agroecology: The Ecology of Sustainable Food Systems. Technology & Engineering.
5. Gliesmann, S.R. (2006). Field and Laboratory Investigations in Agroecology. Technology & Engineering.
6. Paul A. Wojtkowski, P.A. (2004). Landscape agroecology, Haworth Press, Inc., New York. 330 pp.
7. Environmental Biotechnology - Theory and Application – M. H. Fulekar: CRC Press and Science Publisher, USA
8. M. H. Fulekar (2005) Environmental Biotechnology Oxford IBH Publishing cooperation.
9. Environmental Biotechnology-Alan Scragg,Oxford University Press. 6. Environmental Biotechnology, A BiosystemsApproach, Author(s):Daniel A. Vallero, PhD, ISBN: 978-0-12-375089-1,Copyright © 2010 Elsevier
10. Bruce Rittman, Perry L. McCarty (2000). Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000. Environmental Biotechnology: Basic Concepts and Applications. 2006, Indu Shekhar Thakur, I. K. International Pvt Ltd.

SEMESTER-IV (Theory): ELECTIVE PAPER-IV

BOTPG-ET-402-5: BIOCHEMISTRY

Total Max. Marks-100 **Total Credit-04**

UNIT-I: PROTEIN BIOCHEMISTRY 15 Hrs.

Protein sorting and vesicle traffic; Machinery for protein sorting; Protein targeting to different organelles; Protein-protein interactions, protein-DNA interactions; Protein degradation; Proteins in diseases: Alzheimer, Parkinson, BSE. Strategies for protein purification, Use of vectors for over-expression of proteins, Tagging for protein expression

UNIT-II: SIGNAL TRANSDUCTION 15 Hrs.

Overview, second messengers and G-proteins; Phospholipid signaling; Role of cyclic nucleotides. Cacium-Calmodulin cascade; Protein kinases and phosphtases; Two component sensor-regulator system in bacteria and plants, quorum sensing; Gibberellin and Auxin signal transduction in plants.

UNIT-III: IMMUNOLOGY 15 Hrs

Introduction: immune system, organs, immune cells; Types of immunity: innate and adaptive; Antigens: types, properties, antigen-antibody interaction; Major histocompatibility complex: Class I and II MHC molecules; Cytokines: types, mechanism of action and therapeutic uses

Immunity in Health & Disease: Immune response to infectious diseases, Immunodeficiency and AIDS.

UNIT-IV – RECOMBINANT DNA TECHNOLOGY 12HRS.

An overview, Gene cloning: tools and techniques; Vectors: Plasmids and bacteriophages; purification of plasmid, bacteriophage and cell DNA. DNA manipulative enzymes, Manipulation of DNA, transformation, selection, DNA libraries, PCR, DNA sequencing. RNA interference

REFERENCES:

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. Brown TA. (2002) Genomes, BIOS Scientific Publishers Ltd, Oxford, UK.
3. Brown TA. (2008) Gene cloning and DNA analysis (5th Edition),Blackwell Publishing, Oxford, UK.
4. Lodish H, Berk A, Kaiser CA and Krieger M. (2008) Molecular Cell Biology, 6th Edition, W.H. Freeman and Company, New York, USA.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. 2004. Molecular Biology of th
6. Gene, Pearson Education, Singapore.
7. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H., Freeman and Company, New York, USA.
8. Kuby, J. 2000. Immunology, 4th edition, W.H. Freeman and Company, New York, USA.
9. Roitt *et al*., 1998, Immunology 5th edition, Mosby International Ltd. London. UK.

SEMESTER-IV (Theory): ELECTIVE PAPER-IV

BOTPG-ET-402-6: PHARMACOGNOSY AND PHYTOCHEMISTRY

Total Max. Marks-100 **Total Credit-04**

UNIT-I FUNDAMENTALS OF PHARMACOGNOSY 15 Hrs

Definition, scope and applications in herbal medicine. Classification and identification of drugs: Need for classification of drugs; classical (taxonomic, morphological, organoleptic, therapeutic); microscopy and modern (biogenetic) criteria for classification of powdered drug, methods for documentation of raw drugs. Drug evaluation.

UNIT-II: DRUG ADULTERATION 15 HRS

Types, methods of evaluation - biological, anatomical, physical, Phytochemical investigation. Global trend in herbal market. Status of Indian medicinal plant trade, medicinal plants prohibited from export. WHO regulation of herbal medicine. CHMP/ CVMP guidelines of the European Medicines Agency Inspections

UNIT-III: PHYTOCHEMICAL EXTRACTION 15 HRS.

Introduction, definition, factors influencing the choice of extraction. Principles of extraction methods, types of extraction. Extraction of Plant drugs by Microwave assisted techniques and their merits and demerits. Selection of Solvents for extraction. Methods of isolation, purification and characterization of some natural products: Podophyllin, Ginsenosides, Curcumin, Cordycepin,Lemon grass oil, Emitine, Artimisinin, Quinine etc.

UNIT-IV: BIOACTIVE SECONDARY METABOLITES 15 HRS.

Steroids: Occurrence and distribution in plants, saponins, sapogenins and steroids; Isolation, and biosynthesis of bioactive steroids such as cholesterol, diosgenin, estrone, estrodiol, etc.; *Terpenoids*: Occurrence and distribution in plants, essential oils, aroma chemicals, mono and sesquiterpenoids, their use in flavour and perfumery industry, diterpenes, triterpenes, isolation and characterization of terpenes, their synthesis; *Alkaloids*: occurrence and distribution in plants, bioactive alkaloids-isolation and structure elucidation of alkaloids such as atropine, quinine, papaverine, thebaine, vincristine, etc.;

REFERENCES

1. Dey. P.M. and J.B.Horborne: Plant Bio Chemistry Acadamic Press, London.
2. Sadasivam. S. and A. Manickam : Bio Chemical methods 2nd edition. New Age International Pvt. Ltd. New delhi.
3. Dennis D.T., Turpin, D.H. Lefebvre, Layzell D.D and D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
4. Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications
5. Leninger A.C 1987. Principles of Biochmistry, CBS Publishers and Distributers (Indian Reprint).

SEMESTER-IV (Practical): ELECTIVE PAPER-V

BOTPG-ET-403-1: TAXONOMY LAB

Total Max. Marks-100 **Total Credit-04**

1. Specimens collection and handling
2. Taxonomic literatures – Check lists, Floras, Keys, Monographs and Laboratory identification manuals.
3. Preparation of artificial keys.
4. Understanding of phylogenetic classifications.
5. Chemotaxonomy – Flower pigment analysis of plants from Caryophyllales and Curvembryae.
6. Palynotaxonomy – Study of pollen characters of taxonomic significance.
7. Cytotaxonomy – Study of intergeneric / interspecific karyotypic differences.
8. Numerical taxonomy-study attributes, coding, statistical analysis
9. Molecular Taxonomy: Specimen collection, Isolation of DNA,
10. DNA-purification, quantification.
11. Gain a basic understanding of botanical vocabulary and terminology.
12. Learn about major themes and trends in plant evolution.

SUGGESTED READINGS

1. Angiosperm Phylogeny Group 2003. An update of the Angiosperm Phylogeny Group
2. Classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
3. Crawford, D.J. 2003. Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
4. Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.
5. Judd, W.S., C.S. Campbell, E.A. Kellogg, P.F.Stevens and M.J. Donoghue 2002. Plant Systematics: A phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
6. Maheshwari, J.K. 1963. The Flora of Delhi, CSIR, New Delhi.
7. Nei, M. and S. Kumar 2000. Molecular Evolution and Phylogenetics. Oxford University Press, New York.
8. Radford, A. E., W.C. Dickison, J.R. Massey and C.R. Bell 1974. Vascular Plant Systematics. Harper and Row, New York.
9. Semple, C. and M.A. Steel 2003. Phylogenetics. Oxford University Press, Oxford.
10. Michael,G. Simpson. Plant Systematics. 2006. Elsevier Academic Press, Burlington, MA.

SEMESTER - IV (Practical): ELECTIVE PAPER-V

BOTPG-ET-403-2: PLANT PATHOLOGY LAB
Total Max. Marks-100 **Total Credit-04**

1. Preparation of culture media.
2. Methods of sterilization.
3. Isolation of bacterial plant pathogen from diseased tissue.
4. Isolation of fungal plant pathogen.
5. Study of the Fungal diseases: Club root, Damping off, White rust, Early and late Blight, Downy mildew, Powdery mildew, Smut, Rust, leaf spot, Anthracnose, Rot, Wilt.
6. Bacterial Diseases: Citrus canker, Blight and Leaf Spot, Grassy shoot disease and Little leaf,
7. Viral disease: TMV,Yellow mosaic
8. Nematode disease: Root knot
9. Treatment methods for Seed/propagules disinfection for disease free planting
10. Treatment methods for soil disinfection
11. Diagnosis of plant diseases using molecular tools.
12. Symptomatology and histopathology of locally available disease-plants.

REFERENCES:

a) Agrios, G. N. 1978: Plant Pathology
b) Aneja, K. R. 1993. : Experiments in Microbiology, plant pathology and Tissue culture
c) Metcalf & Flint –Desructive & useful Insects.
d) J.B. Free – Insect pollination of field crops.
e) D.S. Bindra- Plant Protection and equipments.

SEMESTER-IV (Practical): ELECTIVE PAPER-V

BOTPG-ET-403-3: PLANT TISSUE CULTURE LAB

Total Max. Marks-100 **Total Credit-04**

1. Requirement for Plant tissue culture works: Work station, equipments and culture conditions.
2. Preparation of MS media stock solution and hormones.
3. Media Preparation & Sterilization.
4. Preparation of explants & callus induction techniques.
5. Micropropagation through axillary bud culture.
6. Induction of Somatic embryogenesis.
7. Anther/ovary culture
8. Isolation of protoplasts.
9. Suspension culture.
10. Preparation of synthetic seeds.
11. Hardening and Acclimatization.
12. Transformation of callus through *A.tumefaciens.*

TEXT BOOKS:

1) Krishnamurthy, K.V, 1988. Methods in plant histochemistry. Viswanathan printers and publishers, Chennai.
2) Lindsley,K. 1992.Plant tissue culture manual. Kluwer Academic publishers.
3) McClung, C.L, 1961. Hand book of Microscopic technique. MacGraw Hill, New Delhi.
4) Purvis, C.J., Collen, D and Walls, D. 1966. Laboratory technique in Botany. Orient Longman, Singapore.
5) Reinert .J and Yeoman, M.M 1983 Plant cell and Tissue culture- Laboratory manual, Narosa publishing house, New Delhi
6) Patki, L.R, 1992. An introduction to Mictotechnique. S. Chand & Co, New Delhi.
7) Prasad and Prasad, 2000. Outlines of Microtechnique. Emkay publ, New Delhi.
8) Thorpe, T.A. 1981. Plant tissue culture methods and application in agriculture, Elsevier, London

SEMESTER-IV (Practical): ELECTIVE PAPER-V

BOTPG-ET-403-4: ENVIRONMENTAL BIOLOGY LAB

Total Max. Marks-100 **Total Credit-04**

1. To estimate the biomass allocation pattern in grassland community.
2. Determination of Dissolved oxygen by Winkler method.
3. Study of phytoplankton in an aquatic ecosystem.
4. Determination of litter accumulation in forest stand.
5. Determination of pH of soil and water by using p^H meter.
6. Study of root nodules of leguminous and non leguminous species.
7. Estimation of NO_3 from water and waste water.
8. Estimation of phosphate from water and waste water.
9. Study of girth increment in tree species
10. Study of density of invasive species and native species.
11. Data collection using Global positioning system(GPS)
12. Land use/ land cover delineation from satellite imagery using visual interpretation technique.

REFERENCES:

1. Brewer, R. and McCann, M.T. (1982).Laboratory and field manual of ecology. Saunders College Publishing.
2. APHA, (2005). Standard methods for the examination of water and wastewater (21st edition). American Public Health Association (APHA), AWWA, WPCF, Washington, DC, USA. De, A K. (2006). Environmental chemistry. New Age International. Michael, P. (1984).
3. Ecological methods for field and laboratory investigations. Tata McGraw Hill, New Delhi.
4. Husch, B., Beers, T.W. and Kershaw, J.A. (2003). Forest mensuration. John Willey and Sons.

SEMESTER-IV (Practical): ELECTIVE PAPER-V

BOTPG-ET-403-5: BIOCHEMISTRY LAB

Total Max. Marks-100 **Total Credit-04**

1. Estimation of DNA (DPA Method)
2. Estimation of total proteins [Bradford's / Lowry's]
3. Effect of pH on enzyme activity.
4. Estimation of PPO oxidase from plant sample.
5. Estimation of Ascorbic acid [Calorimetric / volumetric]
6. Estimation of Riboflavin
7. Estimation of Phenolics [Folin – Ciocalteau]
8. Estimation of Tannins [Folin – Denis / Vanillin hydrochloride]
9. Separation of proteins by SDS-PAGE
10. Determination of Nitrate reductase activity
11. Estimation of ascorbate peroxidase enzyme from plants
12. Estimation of carbohydrate by Anthrone reagent

REFERENCES:

1. Wilson, E. & Goulding, K.H. 2000 A Biologists' Guide to Principles and Techniques of Practical Biochemistry ELBS.
2. Jayaraman, J. 1985. Laboratory Manual of Biochemistry, Wiley Eastern Limited. New Delhi.
3. Modern Experimental Biochemistry, (3rd Edn.) R.Boyer, Benjamin Cumming, 2000.
4. Practical Biochemistry, Principle and Technique (5th Edn.) K. Wilsen and J. Walker, Cambridge University press. 2000.
5. Plant Biochemistry, P.M dey and J.B. Harborne, Harcourt Asia Ltd. Academic press, 1997.

SEMESTER-IV (Practical): ELECTIVE PAPER-V

BOTPG-ET-403-6: NATURAL PRODUCTS LAB

Total Max. Marks-100 **Total Credit-04**

1. Determination of tannins.
2. Determination of flavonoids.
3. Pharmacological screening of Anti-diabetic Agents.
4. Determination of anti-oxidant activity from local plants.
5. Screening of Crude Drugs for Anti-microbial activity.
6. Phytochemical screening methods: Paper Chromatography, TLC, HPLC, Spectrometry.
7. Estimation of Alkaloids from local plants.
8. Identification of amino acids by Paper Chromatography.
9. Identification and Estimation of Lipids
10. Qualitative determination of Phenols from local plants.
11. Determination of adulteration in crude drugs.
12. Determination of extractive value of crude drugs.

REFERNCES

1. Horborne. J.B. 1983. Phyto chemical methods. Chapman and Hall. London.
2. Trease. G.E. and Evanes W.C.Pharmacognosy. 12 Edition. Bailliere, Tindall, East Bourne, U.K. 1983.
3. Kokate. C.K.Purohit A.P. and S.B. Gokhale. Pharmacognosy Nivali Prakashan Publication.
4. Miller.L.P. Phyto chemistry. 1-3 volumes Van Nostrand, Reinhold Co. 1973.

SEMESTER-IV (DISSERTATION): ELECTIVE PAPER-VI

BOTPG-DV-404: DISSERTATION AND VIV-VOCE)

Total Max. Marks-100 **Total Credit-04**

On any topic related to one of the following specialization assigned to the student:

1. Plant Taxonomy and Biodiversity
2. Microbiology and Plant Pathology
3. Plant Biotechnology
4. Plant Ecology
5. Plant Biochemistry
6. Ethnopharmacology and Herbal Medicine