

PG- Semester-III

BOTPG-301C PLANT ANATOMY

(Credits: Theory-3,Practical-1)

THEORY Lectures:48

Unit-1: Cell wall:

Lecture-08

- Function, types and ultrastructure of cell wall, modification and chemical changes of the cell wall, transfer cells, growth of cell wall by intussusception and apposition. Methods of studying cell wall

Unit-2: Cambium:

Lecture-08

- Origin and activity of vascular cambium; factors influencing the activity of vascular cambium; accessory and cork cambium, wound healing ; Periderm: development and structure, rhytidome, polyderm and lenticels.

Unit-3: Wood anatomy:

Lecture-08

- Axially and radially oriented elements; Types of rays and axial parenchyma, annual rings, Softwood & Hardwood, Sapwood and Heartwood, Ring porous and Diffuse porous wood; Reaction wood, tylosis and tylosoid.

Unit-4: Nodal and Floral Anatomy:

Lecture-08

- Types of nodes, leaf trace and leaf gaps, root-stem transition
- Floral apex and vascular anatomy of floral Parts. .

Unit-5. Applied aspects of plant anatomy:

Lecture-08

- To identify fragmentary plant materials, wood and archaeological plant remains, to detect adulterants and contaminants in food and crude drugs , Taxonomic applications, Forensic applications and Paleobotany.

Unit-6: Protective and Secretory Structures:

Lecture-08

- Cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of each), hydathodes, salt glands, nectaries; ducts and cavities, lithocysts and laticifers.

Suggested Readings:

- Easau, K. 1983. Plant Anatomy – Wiley Eastern Limited.
- Fahn, A. 1977. Plant Anatomy, Pergamon Press.
- Cutter, E. G. & Edward, E. 1978. Plant Anatomy: Experiment and Interpretations Part I and II.
- Mauseth, J. D. 1988. Plant Anatomy – The Nenjamin Cumming Publishing Co.
- Forester, A. S. 1948. Practical Plant Anatomy. D. Van Nostrand Company Inc.

- Roy, Pijush. 2010, Plant Anatomy, New Central Book Agency (P) Ltd.

BOTPG-302C PHARMACOGNOSY AND ECONOMIC BOTANY

(Credits: Theory-3, Practical-1)

THEORY Lectures:48

PHARMACOGNOSY

Unit -1:Introduction:

Lectures-08

- Pharmacognosy as a tool for identification of crude drugs and processed medicine.
- Introduction to the techniques for quality control, monitoring and regulation.
- Identification and standardization of herbs and herbal products.
- Standard Techniques for collection and processing, packaging and maintenance of herbs and herbal products
- Classification of crude drugs.
- Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs.
- Contamination of herbal drugs with special reference to Aflatoxins, Heavy Metals and Pesticides.

Unit-2: Quality control of herbal drug:

Lectures-08

- Evaluation and Adulteration of Crude Drugs
- Quality Control Methods for Herbal Drugs:
- Macroscopic and Microscopic Examination
- Chromatography
- Water Content
- Spectroscopy
- Ash Value
- Volatile Oil Determination
- DNA Analysis (DNA fingerprinting, DNA microarray and DNA barcoding).

Unit-3:Secondary Metabolites and Pharmacognosy:

Lectures-08

- Biosynthesis of Secondary Metabolites with special reference to phenolics .
- Pharmacognosy of the following plants: -
 - *Taxus*
 - *Podophyllum*
 - *Panax,*
 - *Andrographis*
 - *Swertia*
 - *Curcuma and*
 - *Camellia sinensis*

Unit-4:Analytical pharmacognosy:

Lecture-08

- Phytochemical screening of plants.

- Phytoconstituents important to therapy:
 - Alkaloids
 - Flavonoids
 - Cardiac Glycosides
 - Steroids
 - Tannins
 - Volatile oils and Resins.
- Toxicity of commonly used medicinal plants: Side effects, cautions and contraindications.

ECONOMIC BOTANY:

Unit-5:

Lecture-08

- Centres of origin of cultivated plants, their importance with reference to Vavilov's work. Plants in commerce & industry- Tea , Sugarcane, Cotton, Rubber, Jute, Bamboo

Unit-6:

Lecture-08

Origin, Botany and uses of the following:

- **Cereals**-Rice & wheat with special references to cultivation and processing;
- **Legumes**-Gram and Soyabean;
- **Spices**-Ginger & Pepper;
- **Dyes**- Achiote (Bixa) and Henna;
- **Masticatories**: Arecanut, Beetle Leaf and Tobacco;
- **Beverages**-Tea and Coffee with special references to cultivation and processing

Suggested readings (Pharmacognosy):

- Bruneton, J. (1999). Pharmacognosy: Phytochemistry of Medicinal Plants. Lavoisier Publishing.
- Dewick, P.M. (2002). Medicinal natural products :a biosynthetic approach. Wiley.
- Charlwood and Banthorpe (1991). Methods in Plant Biochemistry. Academic Press.
- Trease and Evans,(2002). Pharmacognosy. W. B. Saunders Company.
- Mukherjee P. K. (2002). Quality control of Herbal Drugs–An approach to Evaluation of Botanicals, Business Horizons, New Delhi, 1st Edition.
- Kokate, C.K., A.P. Purohit & S.P. Gokhale, 2000. Pharmacognosy, Nirali Prakasan.
- Kar A, Pharmacognosy and Pharmacobiotechnology, 2nd Edition, New Age international publisher

Economic Botany:

- Pandey B P. 2015. Economic Botany. S.Chand
- Kochhar S.L. 2016. Economic Botany in the Tropics. A comprehensive study.

- Sambamurty A.V.S.S. and N.S. Subrahmanyam . Economic Botany of Crop Plants. Asiatech Publishers Inc., Delhi
- Miglani S, 2016. A Textbook of Economic Botany. ABS Books.
- Verma V, 2009. Textbook of Economic Botany. ANE Books.

BOTPG-303C PLANT BIOTECHNOLOGY AND BIOSTATISTICS

(Credits:Theory-3,Practical-1)

THEORY Lectures:48

Biotechnology :

Lectures-38

Unit-1- Plant tissue culture and in vitro morphogenesis:

- Plant tissue culture techniques, embryo culture and its applications, embryogenesis and organogenesis, micropropagation, haploids and their applications, somaclonal variations and applications, Endosperm culture and production of triploids.
- Introduction to protoplast isolation, somatic hybridization. Protoplast and tissue culture for genetic manipulation of plants, crop improvement and development of transgenic plants. Single cell protein (SCP), economic implications of SCP.

Unit-2- Genetic manipulations and practical utility

- Basic concept of recombinant DNA technology, principles of gene cloning. Restriction modification systems, use of restriction enzymes in biotechnology, cloning vectors, methods of gene transfer, DNA libraries, Introduction to PCR, RFLP.
- Development of recombinant vaccines, monoclonal antibody their applications. Introduction to transgenics, gene therapy, Production of secondary metabolites/products: Insulin, growth hormones and interferons.

Unit-3- Introduction to bioinformatics and data generation

- Bioinformatics and its relation with molecular biology, related tools, databases(protein, nucleic acid and structural databases) and data retrieving system
- Data generation: Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray).

Unit-4 Bioinformatics and application

- Applications of Bioinformatics.
- Genome Annotation, Genome Assembly, Structural and Functional Genomics.
- Concept of metabolome and metabolomics, drug discovery and designing
- Chemoinformatics and cheminformatics tools for drug discovery.

Biostatistics

Lectures-10

Unit-5

- Sampling of data, frequency distribution, Measures of central tendency (mean, mode, median), Variance, Standard deviation and Standard error and coefficient of variation.

Unit-6

- Correlation and regression, Probability, Test of significance (t-test, chi-square test), ANOVA.
- Principles of design in biological experiments, Randomized design. Randomized block design, split plot design, Latin square design.

BOTPG-304 C LAB (Credit-3)

PRACTICALS OF

A. PLANT ANATOMY

Credit-1

B. PHARMACOGNOSY AND ECONOMIC BOTANY

Credit-1

C. BIOTECHNOLOGY AND BIostatISTICS

Credit-1

A Plant anatomy:

- Study of anatomical details through permanent slides/temporary stain mounts/macerations/museum specimens/photographs of the following: trichomes (non-glandular and glandular), hydathodes, nectaries, ducts and cavities, lithocysts, laticifers and lenticels.
- Study of nodal anatomy in the following specimens - *Nerium*, *Chenopodium album*, *Azadirachta* and *Coriandrum sativum*.
- Wood anatomy - ring porous; diffuse porous; heart-and sapwood, tylosis and tylosoid
- Study of anomalous secondary growth in stems and root of the following specimens: *Bignonia*, *Tinospora*, *Boerhaavia*, *Calotropis*, *Beta vulgaris*, *Ipomea batatus*.

B. Pharmacognosy and Economic Botany:

Pharmacognosy:

- Qualitative and quantitative analysis of at least one in each class of the following phytochemicals:
 - Alkaloids
 - Flavonoids,
 - Phenolics,
 - Tannins and
 - Volatile oil.
- Separation of phytochemicals by TLC .
- Determination of anti-oxidant activity from plants.

Economic botany:

Collection and submission of economically important plant/plant products.

C. Biotechnology and Biostatistics

- Preparation of culture media and micropropagation
- Isolation and estimation of DNA in plants
- Separation of DNA by Agarose gel electrophoresis.
- Sequence alignment, Sequence homology and Gene annotation.
- Construction of phylogenetic tree
- To work out statistical problems on standard deviation, standard error, variance and coefficient of variation on biological data.
- Problems on Probability, Correlation and regression and on test of significance

BOTPG-3050E BIOFERTILIZER AND BIOREMEDIATION

(Credits:Theory-3, Tutorial-1, Practical-0)

THEORY Lectures:48

Unit-1:

Lectures-04

- **Biofertilizers:** Definition, types and applications in agriculture

Unit-2:

Lectures-06

- **Characteristics of biofertilizers:** *Rhizobium*, *Azotobacter*, *Azospirillum*, phosphate-solubilizing microorganisms (PSMs), cyanobacteria, *Azolla*, mycorrhizae

Unit-3:

Lectures-12

- **Biological nitrogen fixation:** Nitrogenase, substrates for nitrogenase, mechanism of action of nitrogenase, strategies to exclude oxygen and need to control hydrogen evolution, regulation of nitrogen fixation, *Rhizobium*-legume symbiosis

Unit-4:

Lectures-08

- **Production technology:** Strain selection, sterilization, growth and fermentation, mass production of various biofertilizers

Unit-5:

Lectures-06

- **Application technology:** Standard and quality control, application for field and tree crops, nursery plants and seedlings, agronomical significance

Unit-6:

Lectures-12

- **Bioremediation:** Introduction, Fundamental principles, In-situ bioremediation of soil and ground water, Ex-situ bioremediation of soil, Waste water bioremediation, Phytoremediation, Innovative treatment technologies, Bioremediation in practice.

Suggested readings:

- Smith RJ, Lea PJ, Chaplin JR (1999) Nitrogen Fixation. In : Plant Biochemistry & Molecular Biology, 2nd edition, eds: Lea PJ, Leegood RC, John Wiley & Sons, New York, pp. 137-162.
- Rai AN (1990) A Handbook of Symbiotic Cyanobacteria, CRC Press, Boca Raton, USA.
- Stacey G, Burris RH, Evans HJ (1992) Biological Nitrogen Fixation, Chapman & Hall, New York.
- Sprent JI, Sprent P (1990) Nitrogen Fixing Organisms: Pure and Applied Aspects. Chapman & Hall, London.

- Kannaiyan S, Kumar K, Govindrajan K (2007) Biofertilizers Technology, Saujanya Books, New Delhi.
- Bruce E. R., Perry L. McCarty (2001), Environmental Biotechnology: Principles and Applications. McGraw-Hill,
- Rajendran P., Guansekar P (2011) Microbial Bioremediation, Mjp Publishers.

BOT-306C SPT-1: Special paper-I
(Credits: Theory-3, Tutorial-0, Practical-2)
THEORY Lectures:48

- A. Angiosperm Taxonomy-I
- B. Advanced Plant Physiology and Biochemistry-I
- C. Cell Biology, Genetics and Molecular Biology-I
- D. Mycology and Plant Pathology-I
- E. Microbiology-I
- F. Plant Ecology-I

A. ANGIOSPERM TAXONOMY

Unit-1: **Lectures-08**

- Aim, objectives and principles of taxonomy; Historical development of classificatory systems; Artificial, natural and phylogenetic systems of classification.

Unit-2 **Lectures-08**

- Concept of phenetic, phyletic, cladistic and APG; Alpha and Omega taxonomy; Taxonomic structure – taxonomic hierarchy, concept of species, genus, family and infra- specific categories.

Unit-3: **Lectures-08**

- ICN- application of ICN in naming a new taxon, Type concept and its significance, typification, rule of priority, effective and valid publication, retention, choice and rejection of names, nomina conservanda, different codes of nomenclature; Name changes in taxonomy.

Unit-4: **Lectures-08**

- Flora and forest types of North East India; endemic and exotic elements in North East flora; rare and endangered plants of India with special reference to NE India and their conservation; Evolutionary trends in Angiosperms, cradle of flowering plants.

Unit-5: **Lectures-08**

- Phylogeny and floral evolution of following angiospermic orders: Magnoliales, Ranunculales, Malvales, Fabales, Lamiales, Asterales, Orchidales, Poales, Zingiberales (following Takhtajan).

Unit-6: **Lectures-08**

- Major problems of Taxonomy teaching and research in India and some remedies, Role of plant taxonomy in different branches of plant research including medicinal plants research, forensic science and CITES operation, Population concept in taxonomy.

Suggested readings:

- Cronquist, A. 1988. Evolution and Classification of Flowering Plants. New York Botanic Gardens, Bronx, New York.
- Good, R. 1974. The geography of flowering plants. Longman, London.
- Greuter, W. et al. International Code of Botanical Nomenclature. St. Louis Code. Koeltz Scientific Books, Königstein.
- Hutchinson, J. 1964. Genera of flowering plants. Cambridge University Press, London.
- Hutchinson, J. 1974. The families of flowering plants: Oxford University Press.
- Simpson, M.G. 2006. Plant Systematics– introduction, definition, importance and simpson. Elsevier Academic Press.
- Sivarajan, V.V. and Robinson, N.K.P. 1991. Introduction to the principles of plant taxonomy. Oxford IBH.

B. ADVANCED PLANT PHYSIOLOGY AND BIOCHEMISTRY-I

Unit-1: Water relations, Transport and nutrition in plants:

Lectures-08

- Water potential and plant cell, Hydraulic conductivity, stomatal conductance
- Light and microbes induced signalling in guard cell, regulation of water supply, Aquaporins: Dynamic roles and regulations,
- Winter Water Relations and Freezing Tolerance
- Phloem transport in plants, Glucose and sucrose transporter in plant
- Mineral uptake and transport, boron, phosphate, sulphate and iron transporter in plant
- Structure and function of HKT, CaX, NHX & ZIP transporter in plant

Unit-2: Molecular aspects of plant metabolism

Lectures-06

- Physiological and molecular aspects of photosynthesis. Enhancing plant photosynthesis, C₄ rice.
- Molecular aspect of biological nitrogen fixation (BNF) in plants: Organization, function and regulation of *nif* and *nod* genes, genes for nitrate assimilation in plant, transcriptional and post transcriptional regulation of nitrate assimilation in plant, NO metabolism in plant.
- Molecular aspects of seed germination and dormancy

Unit-3: Signal transduction and physiology of plant:

Lectures-08

- Receptors and G-proteins, phospholipid signaling, calcium-calmodulin cascade, diversity in protein kinases and phosphatases. Two component sensing/signalling system in plants. Role of cyclic nucleotides, miRNAs, circular RNAs and long-non coding RNAs in plant growth, morphogenesis and flowering. Hormonal cross talk in plant development

Unit-4: Analytical approaches and molecular plant physiology:

Lectures-08

- Analysis of gene expression at RNA and protein level in plants during different physiological phenomena, Plant phenomics, Global expression profiling by NGS and comparative proteomics

analysis. Genome editing in plant, Protein sequencing methods, detection of post translation modification of proteins. Detection of molecules using northern blot, western blot, immunoprecipitation, and immunofluorescence microscopy.

Unit-5: Stress physiology in plants:

Lectures-12

- Types of stress, biotic and abiotic stress, (HSP, LEA). Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavy metals, radiations and their impact on plant growth and metabolism, stress management. Oxidative stress, reactive oxygen and nitrogen species. Stress management in plants. Role of *in-vitro* culture in plant propagation and production of stress tolerant plants.
- **Antioxidative defence system in plants**–Reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defense mechanism.
- **Chemical defence:** Biochemical mechanisms of plants' chemical war against other plants and animals. Plant responses to herbivory; constitutive defence mechanisms; induced phytochemical responses; biochemical mechanisms of allelopathy.

Unit-6: Plant toxin and tree physiology

Lectures–06

- Mycotoxins, lathrogens, nitriles, protease inhibitors, protein toxins in plants.
- Leaf canopies, radiation environment, effect of irradiance in plants, Light-Response Curve of Sun and Shade Leaves, Physiological and Biochemical, Differences Between Sun and Shade Leaves. Responses to variable Irradiance in plant

Suggested Readings:

- Buchanan B.B, Gruissem W and Jones R.L (2007). Biochemistry and Molecular Biology of Plants. 1st Edition IK International.
- Salisbury F.B. and Ross C.W (1992). Plant physiology (Fourth Edition) Wadsworth Publishing Company, California, USA.
- Taiz L. Zeiger E, Moller IM and Murphy A. (2014). Plant Physiology and Development (Sixth Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.
- Norman P. A. Huner, William G. Hopkins (2013) Introduction to Plant Physiology-4th Edition, Wiley India Pvt. Ltd
- Sinha R K (2014). Modern Plant Physiology, Narosa Publishing House, India
- David L Nelson and Michael M. Cox (2017) (seventh Edition), Leninger Principles of Biochemistry, W. H. Freeman and Company.

C. CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY–I

Unit-1: Gene and Inheritance pattern:

Lectures-08

- Gene & eukaryotic Chromosome, Gene interactions, Extra nuclear, Quantitative and Sex linked inheritance, Multiple alleles, Linkage; Genetic mapping.

Unit-2: Genome organization:

Lecture-08

- Organization of nuclear and organelle genome; transposable elements (yeast, maize and drosophilla), DNA packaging; genome evolution.

Unit-3: DNA replication: **Lecture-08**

- Replication of eukaryotic linear DNA Singled-stranded circular, double- stranded circular and double-stranded linear DNA (viral); Role of enzymes and protein factors in DNA replication

Unit-4: Recombination: **Lectures-08**

- Recombination in Bacteria, fungi and Virus; homologous and site specific recombination; somatic recombination,

Unit-5: Mutation and DNA repair: **Lectures-08**

- Gene Mutation, Mutation at Biochemical and molecular level; DNA damage & repair.

Unit-6: Genetic material in population: **Lectures-08**

- Gene frequencies and equilibrium, changes in gene frequencies, Genetic structure of population, speciation and control of human evolution. (Biological evolution & limitation, deleterious gene and eugenics).

Suggested Readings:

- Ahluwalia.K.B. (2009) Genetics-, New Age International. .
- Elrod S. &Stansfield W. (2004) Genetics, Tata McGraw Hill.
- Geoffrey,M.C.& Robert E.H.(2009),The Cell –A molecular Approach, ASM Press,Wasington D.C & SINAUER Associated.INC Sunderland,Massachusetts.
- Gupta,P. K (2009) Genetics, Rastogi Publications.
- Sharma, A.K. & Sharma, A. (1980), Chromosome Technique &Practice. Bullerwort, London.
- Strickberger M. W (2008) Genetics, PHI learning Pvt. Ltd.
- Watson, J.D, Baker,T.A, Bell, S.P., Gann,A, Levine, M,Losick,R (2007) , Cold Spring Harbor Laboratory Press.

D. MYCOLOGY AND PLANT PATHOLOGY (SPECIAL PAPER-1)

Unit-1 : Classification and general characters: **Lectures–08**

- ICN and fungal nomenclature, recent trends in Classification of Fungi and phylogeny.
- Ultra structure of fungal cell
- Reproduction, parasexuality, degeneration of sex, Sex hormones, heterothallism and Spore dispersal mechanism in fungi.

Unit-2: Fungal physiology and ecology: **Lectures–08**

- Factors influencing the fungal growth
- Mode of nutrition, Nutrition in fungi with reference to: i) Carbon ii) Sulphur iii) Potassium iv) Magnesium v)Nitrogen, vi) Phosphorus,
- Important ecological fungal groups, role of fungi in biogeochemical cycle.

Unit-3: Substrate relationship in fungi:**Lectures-08**

- **Fungi in Soil:** Soil as an environment for plant pathogens, techniques of isolation of soil fungi, rhizosphere and rhizoplane, root exudates, root and soil borne diseases and their control.
- **Aerobiology and Plant diseases:** Air micro flora, air sampling techniques, factors affecting the distribution of air microflora, air-borne plant diseases and their control, aero-allergens

Unit-4:Introduction to plant pathology:**Lectures-08**

- History: Milestones in phytopathology with particular reference to India
- Symptoms of plant diseases caused by fungi, bacteria and viruses.
- Epidemiology and disease forecasting, Effects of environmental factors on epidemiology, major epidemics and their social impacts
- physiological changes due to disease in plants

Unit-5: Fungi as welfare to human beings :**Lectures-08**

- Fungi in food processing: soybean products, cheese, fermented milk, other fermented foods.
- Fungal metabolites – General account of production and application: Primary metabolites (vitamins, proteins), Secondary metabolites (antibiotics, pigments, alkaloids)
- Fungi as food
- Concept of biodeterioration and Biodegradation
 - a. Biodeterioration of non-cellulosic and cellulosic materials.
 - b. Role of microorganisms in Biodegradation of organic wastes
- Fungi as pollution indicators and their role in detoxification.

Unit-6: Mycorrhiza and wood rotting fungi:**Lectures-08**

- Kinds of mycorrhizae. Ectotrophic and endotrophic mycorrhizae, their morphology and anatomy. AM- mycorrhiza. Mycorrhiza in plant growth promotion, mycorrhiza in plant disease control.
- Disintegration of tissue by wood rotting fungi.

Suggested readings:

- Ainsworth, G. G. and A.S. Sussman(1973): The Fungi Vols. I, II, III, IV- A and IV-B
- Alexopoulos, C.J. and C. W. Mims (1996): Introductory Mycology
- Bessey, E. A. (1967): Morphology and Taxonomy of Fungi
- Brook, T.D. Smith, D.W and Madigan, M.T. 1984. Biology of Microorganisms, 4th ed.Eaglewood Cliffts. N.J. Prentice-Hall. New Delhi.
- Burnett J.H. 1968. Fundamentals of Mycology. Edwards Arnold Publication.Press
- Ketchum, PA. 1988. Microbiology, concepts and applications. John Wiley and Sons. New York.
- Mehrotra R.S and Aneja R.S 1998.An introduction to Mycology. New Age Intermediate

- Rangaswamy G. and Mahadevan A. 1999. Diseases of crop plants in India (Fourth Edition) Prentice Hall of India Pvt. Ltd. New Delhi.
- 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.
- Webster J. 1985. Introduction to Fungi. Cambridge University Press.

E. MICROBIOLOGY SPECIAL PAPER- I

Unit-1: Methods in microbiology:

Lectures 08

- Isolation and cultivation of microbes from environment- serial dilution and pour-plate method, spread-plate method, streak-plate method, cultural characteristics of different microbes in different media. Biochemical tests for bacterial identification- Carbohydrate fermentation, Triple sugar, Iron-Agar test, IMVIC test, Hydrogen-sulphide test

Unit-2: Soil Microbiology:

Lectures-08

- Soil properties (physical, chemical and biological), Soil microorganisms, methods of enumeration and activity of microbes in environment/soil; Microbes and plant interactions – rhizosphere, and mycorrhizae, degradation of carbonaceous materials in soil – cellulose, hemicellulose and lignin decomposition, factors affecting the decomposition, Soil humus formation. Biogeochemical cycles-carbon, nitrogen and sulphur cycles.

Unit-3: Environmental microbiology:

Lectures 10

- Distribution and implications of microbes in air and water. Waste as resource: organic compost, vermi composting sewage treatment, biodegradation of industrial waste, bioremediation, water pollution management; Application of rDNA technology in waste treatment; degradation of xenobiotic substances (Hydrocarbons, Heavy metals Pesticides) bioremediation.

Unit-4: Microbial Metabolism:

Lectures 08

- An overview of metabolism; Aerobic and anaerobic respiration, fermentation, Principles of bioenergetics: redox reactions and electron carriers; Generation of ATP, An overview of metabolism; catabolic pathways, glycolysis; TCA, pentose-phosphate pathway; bacterial photosynthesis; chemosynthesis; metabolism of fatty acids and amino acids;

Unit-5: Introduction to Immunology:

Lectures 08

- Cells of immune systems, types of immunity, properties of antigens and antibodies. Types of antibody diversity, monoclonal antibodies. Different classes of immunoglobulins, MHC, immune disorders, vaccine and chemotherapy.

Unit-6: Cell signalling:

Lectures 06

- Signalling molecules and their receptors, .Function of cell surface receptors. Pathways of intracellular receptors, cyclic AMP, cyclic GMP and MAP kinases, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

Suggested readings:

- Banerjee, A. K. & N. Banerjee: Fundamentals of Microbiology and Immunology
- Dubey, R. C & D.K. Maheswari: A Text Book of Microbiology.
- Mishra, R. R. 1996. Soil Microbiology. CBS Publ.
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan Roitt M. 2017 Roitt's Essential Immunology, 13th Edition Wiley-Blackwell
- Prescott, L. Harley, J. and Klein, D. (2005) Microbiology, 6th edition, Tata McGraw-Hill Co. New Delhi.
- Subbarao N.S. Soil Microbiology English-OXFORD & IBH Publishing co. Pvt Ltd.

F. PLANT ECOLOGY SPECIAL PAPER -I

Unit-1: Introduction:

Lectures 08

- Importance and scope of ecology, levels of organization, spatial and temporal scales, interaction of ecological factors in the environment, tolerance range and limiting factors, adaptations, genecology.

Unit-2: Soil Science:

Lectures 08

- Soil composition and structure, factors influencing soil formation, properties of soil (physical, chemical and biological), soil organic matter, soil types of India, contribution of soil to ecosystem services.

Unit-3: Population structure and dynamics:

Lectures 08

- Concept, characteristics of a population; population regulation - by abiotic factors - nutrients, moisture, food availability, space, weather and climate; by biotic factors - competition, predation, density, parasites and diseases, natural disasters; Evolutionary strategies (strategies as shown by survivorship curves and r and K-strategies); modular organisms, population interactions; concept of metapopulation - demes and dispersal; interdemec extinctions.

Unit-4: Community organization and development:

Lectures 08

- Nature of communities; community structure and attributes; edges and ecotones; vegetation characteristics (analytical and synthetic characters); methods of sampling vegetation and data analysis; concept of habitat and niche; niche width and overlap; fundamental and realized niche;

Unit-5. Ecological Succession:

Lectures 08

- Concept and changes in ecosystem properties during succession, basic theories; concept of climax, examples of secondary and heterotrophic succession, methods of studying succession.

Unit-6. Ecosystem organization:

Lectures 08

- Structure and functions; primary production (global pattern and controlling factors); ecological energetics - trophic levels, energy flow pathways and ecological efficiencies; decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C,N, P, S and water cycle.

Suggested Readings:

- Chapman, J. L. and Reiss, M. J. (1992). Ecology – Principles and Applications, Cambridge University Press, Cambridge, UK
- Freeman, B. (ed.), 1995. - Environmental Ecology- The ecological effects of pollution, disturbance, and other stresses. Academic press.
- Krishnamurthy K.V. A textbook of Biodiversity, Science Publishers Inc., Enfield, New Hampshire, USA.
- Michael, P. 1990. - Ecological methods for field and laboratory investigations. Tata McGraw Hill,
- Odum, E. P. and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning, New Delhi, India
- Pullin, A.S. (2002) Conservation Biology, , Cambridge University Press, Cambridge.
- Singh, J.S. Singh S.P. and Gupta S.R. (2014). Ecology, Environmental Science and Conservation. S. Chand and Company Pvt. Ltd., New Delhi.

BOTPG-307 SPL-1: Practical Special paper-I (Credits:Theory-0, Tutorial-0, Practical-2)

A. ANGIOSPERM TAXONOMY–I (PRACTICAL)

- Floristic study of certain small area in and around Guwahati, making collection of their own and from these analytical drawings should be made. Describe the specimen using botanical terms and keying out the prominent characters for identification up to the rank of species for the preparation of a flora.
- Handling of floras, manuals, icons and Index Kewensis..

B. ADVANCED PLANT PHYSIOLOGY AND BIOCHEMISTRY–I(PRACTICAL)

- Determination of relative growth rate (RGR) in plant
- Determination of water loss rate(WLR) in plant
- Determination of water and osmotic potential in different plant tissue.
- Determination of chlorophyll a, b and total chlorophyll by Arnon's method.
- Determination of chlorophyll a/b ratio in C₃,C₄ and CAM plants.

- To determine stress tolerance index in plant
- To determine membrane injury index in plant
- To determine carotenoid contents in plant
- To determine mineral translocation efficiency and ratio in plant
- Determination of reducing/total sugar by DNS method.
- Estimation of total carbohydrates by Anthrone method.
- Estimation of fats/oil in different oily seeds.
- Estimation of nitrogen by Kjeldahl's method.
- Estimation of proteins by Lowry's method.
- Separation of soluble proteins by Gel Electrophoresis.

A. CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY–I(PRACTICAL).

- Study of Mitosis in locally available plants.
- Study of Meiosis in locally available plants.
- Study of chromosomal aberration in plant species.
- Study of variation of chromosome number in plant species.
- Isolation of plant genomic DNA and its estimation by spectrophotometric method
- To find out the evolutionary status of plants by karyotype analysis
- Working out genetically problems on Gene interactions, Sex linked inheritance, Multiple alleles, Linkage, crossing over and Genetic mapping.

B. MYCOLOGY AND PLANT PATHOLOGY–I (PRACTICAL).

- Principles & working of tools, equipment and other requirements in the Mycology & Plant Pathology laboratory.
- Isolation and identification of different groups of fungi occurring on different substrates.
- Effect of different physical and chemical factors on the growth of fungi.
- Estimation of enzymes: Cellulases, Pectinases, and Amylases
- Study of antibiotics and enzymes of fungal origins.
- Study of mycorrhiza.
- Study of morphological characters and reproductive structures of fungal species available in Assam.
- Anatomical study of wood infected by fungi
- Demonstration on biodegradation of organic waste.
- Submission of preserved specimens (either wet or dry) belonging to Fungi / Photograph of fungal specimen and slides during the Practical Examination.

E. MICROBIOLOGY SPECIAL PAPER –I (PRACTICAL):

- Basic microbiological techniques: preparation of media, sterilization, slant preparation and pure culture by streak and pour plate method.
- Qualitative and quantitative analysis of soil microbiota
- characterization of selected pure culture

- Study of mycorrhizae.
- Study of air microflora by exposure plate technique.
- Staining of bacterial cells.
- Study of bacterial growth curve by spectrophotometric method.
- Screening of microbes for production of enzymes.
- Screening of microbes for production of organic acids.

F. PLANT ECOLOGY SPECIAL PAPER-IPRACTICALS:

- Study of the following microclimatic variables in different habitats: soil and air temperature, wind speed, relative humidity, rainfall and light intensity.
- To study the physical characteristics (temperature, colour and texture) of soil.
- To determine the water holding capacity of soil collected from different locations.
- To study the species composition of an area for analyzing biological spectrum and comparison with Raunkiaer's normal biological spectrum.
- Determination of Importance Value Index (IVI) of the plant species in the community by quadrat method.
- Estimation of primary productivity of an aquatic ecosystem.
- Determination of hardness of polluted and unpolluted water samples.

SEMESTER– IV

BOTPG- 401C REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY

(Credits: Theory-3, Practical-1)

THEORY Lectures:48

Unit -1: Pre Fertilization events

Lecture-12

- **Male Gametophyte:** Structure of anthers; microsporogenesis; Tapetum-types and role of tapetum; Pollen morphological features; unusual features: pollen development and compound pollen grains.
- **Female Gametophyte :** Ovule Structure, development of monosporic, bisporic, tetrasporic & special types of embryo sacs, megasporogenesis, organisation of the embryo sac; ultra structure & nutrition of female gametophyte.

Unit -2: Pollination and Fertilization

Lecture-08

- Pollen-pistil interaction, self-incompatibility, different methods to overcome self-incompatibility, Pollen germination; pollen tube growth ,entry into the embryo sac and pollen tube discharge, syngamy and triple fusion, Barriers to fertilization. Polyspermy and hetero fertilization