Syllabus

For B. Sc. (Honours) Botany

Submitted to

KAZI NAZRUL UNIVERSITY

Under

Choice Based Credit System

(For Session 2016-2017)

Syllabus for Botany Honours

Kazi Nazrul University, Asansol

Semester – 1

Semester – II

Semester – III

Semester – IV

Semester – V

Semester – VI

Total Credit = 140

Core Course: Botany Honours

Semester.	Papers	Name of the subject	Teaching Scheme In hours per week			Credit
			L	T	P	
I	1	Phycology and Lichenology	4		2	6
I	2	Mycology and Phytopathology	4		2	6
II	3	Bryology, Palaeobotany and Palynology	4		2	6
II	4	Morphology and Plant Anatomy	4		2	6
III	5	Plant systematic	4		2	6
III	6	Phytogeography and Eco. Botany	4		2	6
III	7	Pteridology and Gymnosperms	4		2	6
IV	8	Biochemistry and Plant Metabolism	4		2	6
IV	9	Ecology and Pharmacognosy	4		2	6
IV	10	Microbiology	4		2	6
V	11	Plant Physiology	4		2	6
V	12	Cell Biology and Genetics	4		2	6
VI	13	Molecular Biology	4		2	6
VI	14	Plant Biotechnology and Tissue culture	4		2	6
			Total Credit			84

AECC – Ability Enhancement Compulsory Courses: English/ Modern Indian Language/EVS

AEEC – Ability Enhancement Elective Course

[i.e. Skill Enhancment Course (SEC)]

[Two papers are to be taken and each paper will have 2 credit]:

Discipline Specific Elective Courses (DSE):

(Four papers are to be taken each carrying 6 credit)

DSE- I : Stress Physiology/Ethnobotany

DSE-II: Plant Breeding/ Horticultural Practices

DSE III: Bioinformatics/Research Methodology

DSEIV: Biostatistics/ Cryopreservation

Interdisciplinary/Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credit]:

(Papers are to be taken from any of the following disciplines. (At least two papers are to be taken from chemistry)

1. Chemistry, 2. Zoology, 3. Botany, 4. Physiology, 5. Microbiology.

General Elective: Botany

Semester.	Papers	Name of the subject	Teaching Scheme In hours per week			Credit
			L	T	P	
I	1	Algae, Fungi and Bryophyta	4		2	6
II	2	Pteridophyta, Gymnosperms and Palaeobotany	4		2	6
III	3	Plant Taxonomy and Plant Anatomy	4		2	6
IV	4	Plant Physiology and Ecology	4		2	6

Detailed SYLLABUS FOR BOTANY HONOURS ACCORDING TO CBCS-UGC
KAZI NAZRUL UNIVERSITY
ASANSOL – 03

SEMESTER - 1

Theory – Marks

HBOT-CCT-101

Core Course – I (Marks)

Phycology – marks

1. History and Development in Algae (Contribution of Fritsch and MOP Iyengar)
2. Introduction; Habitat and distribution; thallus organization; origin and evolution of sex in algae; Life cycle patterns.
3. Theory of endosymbiosis with respect to chloroplast evolution in algae.
4. Broad outline of classification of Fritsch (1935) and Lee (2008) up to class and divisions respectively.
5. Cyanophyceae: Salient features, ultrastructure of cell, structure and function of heterocyst; reproduction.
6. Chlorophyceae: Salient features; life history of *Chlamydomonas, Oedogonium* and *Trentepohlia.*
7. Charophyceae: Salient features; life history of *Coleochate* and *Chara*.
8. Xanthophyceae: Salient features; life history of *Vaucheria.*
9. Bacillariophyceae: *S*alient features, cell structure and reproduction.
10. Phaeophyceae: *S*alient features; life history of *Ectocarpus*.
11. Rhodophycee: Salient features; life history of *Polysiphonia*.
12. Economic importance – Beneficial: food. phycocolloids (agar, algin and carrageenan), diatomaceous earth; Harmful: algal as pathogen in plants and algal toxins.
1. Algal Biotechnology- Pollution control (sewage treatment), Biofertilizer, Single Cell Protein (SCP), Biofuel, β-catotene production.

Lichenology Marks-

Lichen: Classification, thallus structures, reproduction; ecological and economic significance.

Internal Assessment -

Core Course – II (Marks)

HBOT-CCT-102

Mycology– marks

2. Status of fungi in living system.
3. Introduction, Salient features - fungal tissue organization, modification of hyphae, structure of fungal cell, flagella, habit, septum, homothallism and heterothallism, parasexuality, cell division.

4. Broad outline Classification of Gwynne-Vaughan and Barnes (1937) and Ainsworth and Bisby (1983).
5. Phycomycetes: Salient features, life histories of *Synchytrium, Saprolegnia* and *Rhizopus.*
6. Ascomycetes: Salient features, Ascus development, types of ascocarps; life histories of.*Saccharomyces* and *Ascobolus*.
7. Basidiomycetes: Salient features (dikaryotization, clamp connection); development of Basidium (holobasidium and phragmobasidium), fruit body types, life histories of *Puccinia, Ustilago* and *Polyporus.*
8. Deuteromycetes: Salient features with special reference to conidial fruit body types.
9. Economic importance of fungi – As food (Mushroom – types; procedure of spawn production and cultivation of Oyster and Button mushroom); Mycorhizae (importance in agriculture and forestry);

Phytopathology- marks

1. Plant Diseases: Definition; concepts of parasitism and saprophytism, Koch's postulate.
2. Classification of plant diseases based on symptoms.
3. Pathotoxins (HV toxin and Wild-fire toxin).
4. Structural and biochemical defense mechanism of plants.
5. Control of Plant diseases: Physical, chemical and biological methods.
6. Symptoms, disease cycles and control measures of White rust of crucifer, Brown spot of rice, Late blight of potato, Rust of wheat.

Internal Assessment - 7

Practicals – Marks

Core Course – I and II (Combined) (Marks)
HBOT-CCP-101 and HBOT-CCP-102

Algae/Phycology -

1. Study of the following genera: *Oscillatoria, Gloeotrichia, Scytonema,Oedogonium,Vaucheria and Chara.*
2. Identification of all the genera included in the theoretical syllabus by their vegetative and reproductive structures.

Fungi/ Mycology -

1. Study of the following genera: *Rhizopus, Ascobolu, Agaricus* (gill) and *Polyporus.*
2. Identification of all the macroscopic and microscopic genera included in the theoretical syllabus. (It should also include *Alternaria* and *Fusarium* of Deuteromycetes).

Phytopathology -

1. Study of the following diseases: White rust, Rust of wheat/*Justicia*, smut of wheat (or any member of Poaceae)
2. Demonstration on isolation and subculturing of pathogen.

SEMESTER – II

Theory – Marks

Core Course – III (Marks)
HBOT-CCT-203
Bryology –marks

1. Origin and evolution of Bryophytes.
2. Introduction, General habit and distribution, Broad outline of Classification according to Proskauer, (1957) and Crandall-Stotler and Stotler (2008); Comparative study of Hepaticopsida, Anthocerotpoida and Bryopsida.
3. Life histories of *Marchantia, Pellia, Porella, Anthoceros, Sphagnum* and *Funaria*.

4. Evolutionary trends in the gametophyte and sporophytes of bryophytes.

Palaeobotany and Palynology- 8 marks

1. Contributions of Birbal Sahni in Indian Palaeobotany.
2. Introduction, importance of Paleobotany.
3. Definition of fossil, process of fossilization, types of fossils on the basis of their preservation; concept of Form Genus, conditions for fossilization.
4. Introductory idea of correlation and stratigraphy; stratigraphic deductions based on plant fossils.
5. Origin of life, Geologic Time Scale, major events of plant life through geologic time.
6. Spore/pollen morphology with reference to polarity, size, shape, symmetry, aperture and sculpture.
7. Importance of Palynology; Melittopalynology.

Internal Assessment – 6 Marks

Core Course – IV (Marks 35)
HBOT-CCT-204
Morphology and embryology of Angiosperms - 16 marks

1. Leaves: Types, phyllotaxy, modifications of leaves, stipules.
2. Inflorescence: Types with examples.
3. Flower – General characteristics, as a modified shoot; aestivation; placentation and its evolution; floral formulae, floral diagram; adhesion and cohesion of floral parts.
4. Fruits: Definition and types.
5. Dispersal of fruits and seeds.
6. Organization of orthotropous ovule, types of ovules; megasprogenesis.
7. Development of male and female gametophytes (*Polygonum* type)
8. Pollination: Types and contrivances.
9. Fertilization.
10. Development of typical dicot embryo (Crucifer - type).
11. Endosperm: Types, development of free nuclear type.

Plant Anatomy – 12 marks

1. Cell wall: Structure, growth and thickenings.
2. Tissue: Definition, organization of shoot and root apices, mechanical tissue and their distribution in plant bodies.
3. Tissue system – Epidermal (multiple epidermis, bulliform cells, stomatal types, trichoblasts, glandular hairs), vascular (leaf gap, branch gap, types of vascular bundles) and ground tissue system (Genral features of cortex, pith and medullary rays); Stele types.
2. Root-stem transition.
3. Secondary growth: normal secondary growth in dicot shoot and root, concept of growth ring, ring and diffused porus wood, heart wood and sap wood, Periderm, Lenticel, commercial cork, bark, polyderm and rhytidome.
4. Anomalous secondary growth in stems of *Bignonia, Boerhaavia, Strychnos*and *Dracaena* (*Cordyline*), significance.

Internal Assessment – 7

Practicals – Marks 35

Core Course – III and IV (Combined) (Marks – 35)
HBOT-CCP-203 and HBOT-CCP-204
Bryophyta-

1. Study of the gametophytic and sporophytic structures of the following genera: *Marchantia, Anthoceros and Funaria.*
2. Spot identification of genera that are included in the theoretical syllabus.

Morphology –

1. Morphological study of the plant organs included in the theoretical syllabus (No Submission is required)

Plant Anatomy -

1. Study of the anomalous structures of stems of the following genera: *Bignonia, Dracaena, Boerhaavia and Strychnos.*

2. Microscopic identification of the followings: Primary structure of Sunflower and maize stem and gram and *Canna* root, Bulliform cells, stomatal types, lenticels, raphides (acicular and sphaeraphides), Cystolith.
3. Maceration of wood elements of *Cucurbita* and *Pinus* stem and their microscopic examination.

Palaeobotany and Palynology –

1. Study (including mode of preservation) of the following: *Lepidodendron,* (stem in T. S.), *Calamites* (stem in T. S.), *Bucklandia* (stem, specimen), *Glossopteris* (leaf, specimen), *Lyginopteris* (stem in T. S.),*Vertebraria*(root, specimen).

SYLLABUS FOR BOTANY HONOURS ACCORDING TO CBCS-UGC
KAZI NAZRUL UNIVERSITY
ASANSOL – 03

SEMESTER - III

Core Course (Theory) –V (50)

Plant Systematics – 40 Marks

1. Position of Plant kingdom in living system (Five kingdom concept),
2. Plant classification - artifitial, natural and phylogenetic approach, concept of molecular chronometers, Basic concept of Numerical taxonomy (Definition of Operational Taxonomic Units (OTU), Phenon, Phenogram).
3. Outline of the system of classification – Linnaeus (1753), Bentham and Hooker (1862-83), Takhtajan (1997). Brief idea about APG.
4. Definition of Taxonomy (alpha & omega), concept of hierarchy and categories.
5. ICN (ICBN) and Principles of ICN, Effective and Valid publication, Principle of priority, authors citation, rejection of names, Nomenclatural types; Importance of herbaria and botanical gardens.
6. Salient features of the following families with examples from common Indian species and economic importance. [Evolutionary trends need to be briefly discussed in case of families marked with astericks].

   Dicotyledons: Magnoliaceae*, Malvaceae, Brassicaceae, Fabaceae, Euphorbiaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbinaceae, Acanthaceae, Rubiaceae, Asteraceae (Compositae)*.

   Monocotyledons: Alismataceae*, Liliaceae, Poaceae, Orchidaceae*.

Internal Assessment - 10

Core Course (Practical) - V (50) (30 Continuous evaluation + 20 External Exam)

2. Study of the morphology of locally available plants of the families included in the theoretical syllabus (excluding, magnoliaceae, euphorbiaceae, and all monocots included in the syllabus) including floral formula and floral diagrams, identification up to genus following published keys (Bengal Plants by David Prain 1903 or any other Published Key). 8
3. Spot identification – $1^1/_2 \times 2 = 3$

4. Submission – (Herbarium sheet with Field Record + Note book) 2 + 2

Submission will include only herbarium sheets of 15 common angiosperms from local flora (EXCLUDING ENDANGERED AND THREATENED SPECIES). Emphasis should be given in preparation of field note book and field record book with photographic documentation.
[N.B. One long excursion to vegetationally rich area (optional) and one local field excursion is recommended for familiarization with the flora. In addition, the field visit to AJC Bose Indian Botanical Garden and CNH, Shibpur, Howrah is mandatory.]

Core Course (Theory) - VI (50)

Economic Botany – 20

1. Method of cultivation, processing and utilities of the products of the following: Rice, Tea, Potato and Jute.
2. Morphological nature and major uses of the economically important parts of the following products: Cotton (fibre), Sal (wood), Sugarcane (sugar), Mustard (oil) and Pegion Pea (Pulse), *Jatropha curcas* (Biodiesel).

Pharmacognosy – 20

1. Introduction; definition of drugs, folk medicine, active principles; Pharmacy, Pharmacognosy, Pharmacopeia and drug adulteration (sophistication), drug evaluation.
2. Study of the following drug plants (Diagnostic features, active principles and uses): *Rauwolfia serpentina* (root), *Adhatoda vasica* (leaf), *Strychnos nuxvomica* (seed), *Catharanthus roseus* (Whole plant), *Taxus* sp. (bark).

Internal Assessment - 10

Core Course (Practical) – VI (50) (30 Continuous evaluation + 20 External Exam)

Economic Botany – T.S. of potato tuber to show localization of starch grains, qualitative test for starch using either rice/potato, Identification of jute fibre through maceration technique, Qualitative test for lipid in crushed seeds of mustard, Whole mount of cotton seed to show lint and fuzz fibres.

Pharmacognosy –

Organoleptic and microscopic examination of following plant drugs to be supplied fresh and powdered form – *Adhatoda vasica* (leaf), *Strychnos* (seed), Zinger (rhizome).

Core Course (Theory) – VII (50)

Pteridophyta- (20)

1. Introduction to Pteridophyta – Concept of sporophyte (evolutionary steps leading to independent sporophyte), stellar organization and evolution, microphyll vs megaphylls, exsporic vs endosporic, exscopic vs endoscopic, soral types; Apogamy and apospory.
2. Outline of Smith et al. (2006) system of classification of pteridophytes up to family.
3. Telome theory of Zimmerman and Enation theory of Bower.
4. A comparative morphology and evolution of *Rhynia, Zosterophyllum* and *Psilophyton,*
5. A comparative account of the living genera: *Psilotum. Lycopodium, Selaginella,* and *Equisetum* with respect to vegetative and reproductive structures.
6. Geological history and morphoanatomical features of *Lepidodendron,(Lepidodendron, Lepidocarpon) v) Calamites (stem and strobilus-Eurostachys and Palaeostachya).*
7. Distribution, vegetative structure and reproduction of *Pteris,*and *Marsilea.*

Gymnosperm- (20)

1. General features, evolution of seed habit; outline classification as adopted by Stewart & Rothwell (1993).
2. Progymnospermopsida: General features, General account of *Archaeopteris*
3. Pteridospermales: General account of *Lyginopteris* plant (*Crossotheca* male organ and *Lagenostoma* female organ).
4. Glossopteridales: General account of *Glossopteris* plant (*Vertebraria* root, *Araucarioxilon* trunk, *Glossopteris* leaf,*Glossotheca*male organ, *Denkania* (female organ).
5. Cycadales: Structure and life history of *Cycas and* its distribution in India.
6. Bennettitales: General account of *Williamsonia* plant (*Bucklandia* stem, *Ptilophyllum* leaf, *Weltrichia* male organ, *Williamsonia*female organ).
7. Ginkgoales: Structure and life history of *Ginkgo;* brief mention of the morphology of collar.
8. Coniferales: Structure and life history of *Pinus*; brief mention of the morphology of ovuliferous scale.
9. Gnetales: Structure and life histories of *Ephedra* and *Gnetum;* their distribution in India.
10. Economic importance of gymnosperms.

Internal Assessment - 10

Core Course (Practical) -VII (50) (30 Continuous evaluation + 20 External Exam)

Pteridophytes –

1. Study of external morphology and anatomical features of leaf, stem and reproductive parts of the following: *Lycopodium, Selaginella, Equisetum, Pteris and Marsilea.*
2. Macroscopic and microscopic identification of specimens of all extant genera included in the theoretical syllabus,

Gymnosperms –

1. Study of the morphological and anatomical features of the following: *Cycas* (leaflet, rachis, microsporophyll), *Pinus* (needle, stem, male cone), *Ephedra* (stem, morphology of male flower).
2. Macroscopic and microscopic identification of specimens of all the extant genera included in the theoretical syllabus –(male and female cones of all genera, leaves of *Ginkgo* and *Gnetum*, Coralloid root of *Cycas*, t.s of ovule of all genera, v.s of cones of all genera in theory syllabus).

SEMESTER – IV

Core Course (Theory) – VIII (50)

Biochemistry (22) –

1. Structure of water molecule and its biological role, Concept of pH, Ionic product of water, acid-base and buffers in biological system, chemical bonds; concept of radioisotopes; Biomolecules.
2. Carbohydrates: Outline classification, reducing and non-reducing sugars. Structures of mono-, di- and polysaccharides, properties of monosaccharides; Concept of Optical isomerism (L and D forms), mutarotation.
3. Amino acids: Basic structure and outline classification with examples; concept of zwitterions and isoelectric point (pI).
4. Protein: Primary, secondary (∞ - helix & ß-pleated sheet), tertiary and quaternary structures; Interactions involved in these conformations.
5. Lipid: Structure and nomenclature of fatty acids.
6. Nucleic acid – Chemical nature of DNA and RNA, Structure of Nitrogenous bases, Nucleotides and Nucleosides. Structure of B-DNA (Watson-Crick model), types of DNA and RNA, Structure of tRNA.

7. Enzymes: Definition, co-factors and prosthetic group with examples. Nomenclature and classification of enzymes (IUB system, 1961). Preliminary idea about the mechanism of enzyme action and kinetics, factors affecting enzyme action, Ribozyme, allosteric enzyme.

Plant Metabolism (18) –

1. Carbon Metabolism – Respiration, Respiratory quotient (RQ), Glycolysis, oxidative decarboxylation, Krebs cycle, electron transport system, oxidative phosphorylation and chemiosmotic system, Glyoxylate cycle, Gluconeogenesis.
2. Nitrogen metabolism - nitrate assimilation, nitrogen fixing organisms (free living, symbiotic and associative diazotrophs), Mechanism of nitrogen fixation – both asymbiotic and symbiotic. Mechanism of nodule formation and concept of nod and nif genes. GS-GOGAT pathway for ammonia assimilation. Definition and examples of transamination, deamination and decarboxylation reactions of amino acids.
3. Lipid Metabolism – β-oxidation of even carbon fatty acids (Palmitic acid).

Internal assessment - 10

Core Course (Practical) - VIII (50) (30 Continuous evaluation + 20 External Exam)

Biochemistry and Plant Metabolism

1. Qualitative tests – General test for carbohydrate (Molish test), tests for reducing and non reducing sugar (Fehling's test), Specific tests for glucose (monosaccharide), starch (Iodine test); General tests for protein (Biuret test and xanthoproteic test), General test for organic acid (Citric acid and Oxalic acid); General tests for essential elements- Fe and phosphorus.
2. Quantitative test – Quantitative estimation of sugar in an unknown sample with the help of known standards (DNS method); Quantitative estimation of protein in an unknown sample with the help of known standards (Lowry test); Concentration should be determined by plotting standard curve.
3. Determination of respiratory substrate of germinating seeds of a carbohydrate, protein and oil rich seed by RQ method
4. Determination of rate of respiration in different plant parts.
5. Determination of seed viability by TTC test.

Core Course (Theroy) - IX (50)

Ecology (25)–

1. Ecology: Concept of Autecology and Synecology.
2. Environmental factors: Climatic, edaphic and biotic factors.
3. Biogeochemical cycle – N_2 and P cycle.
4. Ecosystem: Definition, concept of ecological pyramids and energy flow.
5. Ecological succession (Hydrosere, Xerosere).
6. Morphological, anatomical and physiological adaptations of xerophytes, hydrophytes and halophytes.
7. Biodiversity (hot spots, megadiversity zones, IUCN threatened species), conservation (*in-situ-, ex-situ* conservation and cryopreservation).
8. Pollution: Definition, causes and remedies with respect to air, water and noise pollution.

Phytogeography (15) -

1. Phytogeographical classification of India (D. Chatterjee- 1960).
2. Vegetation characteristic of Eastern Himalayas and Sunderbans.
3. Endemism : Definition, theories and types.
4. Concept and brief description of Major terrestrial biomes.

Internal assessment - 10

Core Course (Practical) – IX (50) (30 Continuous evaluation + 20 External Exam)

Ecology and Phytogeography –

1. Ecological adaptations with respect to anatomy of: *Iponoea aquatica* stem, Phyllode of *Acacia auriculoformis*, *Nerium* leaf and *Vanda* root. 8
2. Concept of minimum species area curve according to quadrate method. 7
3. Determination of Biodiversity of an area by Shannon index method.

Core Course (Theory) – X (50)

Microbiology (40) –

1. Histroy and development of microbiology – contributions of Antoni van Leuwenhoek, Edward Jenner, Loius Pasteur, Robert Koch, De Bary and A. Flemming.
2. Principles and modern approaches of bacterial Taxonomy, General idea about Bergey's Mannual, Three domain system by C. Woese (1991).
3. Bacterial structure and function - Capsule, flagella, pili, cell wall (chemical composition and characteristics), plasma membrane, ribosomes, cytoplasmic inclusions (PHB, Volutin). Plasmids and bacterial chromosome, endospore (structure only); General characteristics of domain Archaea.
4. Economic importance of microorganisms i) Agricultural Microbiology (Biofertilizer, biopesticides), ii) Industrial Microbiology (in fermentation and Pharmaceuticals), iii) Medical Microbiology (air borne – Influenza; Water borne – Cholera; Food borne – Boutulism; Brief idea about epidemiology, causal organism and control).
5. Basics of genetic recombination in bacteria: Transformation, Conjugation and Transduction. Artificial transformation.
6. Viruses: General characteristics of viruses (size, symmetry, culture characteristics, general structure including concept of capsomere and peplomere, chemical composition), structure of TMV, T_2 and HIV; Viral multiplication – Lytic cycle and Lysogeny (excluding regulation).
7. Brief idea about Prion and Viroid.
8. Basic immunology (only outline) – Innate and acquired immunity, active and passive immunity, humoral (antibody mediated) and cellular (cell mediated) immunity, primary and secondary response, general structure of antibody and its types.

Internal assessment - 10

Core Course (Practical) – X (50) (30 Continuous evaluation + 20 External Exam)

Microbiology -

1. Aseptic methods
   a) Sterilization technique by Autoclaving, Hot air oven and surface sterilization.
   b) Preparation of standard bacteriological medium (Nutrient agar and Nutrient broth).
   c) Preparation of slant and plates.
   d) Subculturing of pure bacteriological culture.
2. Microscopic examination of bacteria from natural habitats: curd and root nodules of leguminous plants (using simple staining)
3. Enumeration of culturable bacteria (Colony Count) from air.
4. Differential staining: Gram staining.
5. MBRT test.

SEMESTER - V

Core Course XI:5

Plant Physiology

THEORY (40+10 = 50)

Unit 1: Plant-water relations **(8 lectures)**

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–theories on Ascent of sap. Transpiration and factors affecting transpiration, antitranspirants; mechanism of stomatal movement – K^+-H^+ antiport theory, role of CO_2, sucrose and ABA and blue light response.

Unit 2: Mineral nutrition **(6 lectures)**

Essential and beneficial elements; Macro and micronutrients; Hydroponics; Criteria for essentiality of elements; Mineral deficiency symptoms and roles of essential elements; Heavy metal toxicity on plants; Phytoremediation (basic concept).

Unit 3: Nutrient Uptake **(6 lectures)**

Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption and active absorption of ions, carrier mediated transport, uniport, co-transport, symport, antiport; Nernst equation.

Unit 4: Translocation in the phloem **(6 lectures)**

Experimental evidence in support of phloem as the site of sugar translocation; Source–sink relationship; Phloem loading and unloading, Pressure–Flow Model.

Unit 5: Photosynthesis, Carbon dioxide concentrating mechanisms (CCMs) and Photorespiration **(10 Lectures)**

Photosynthesis: Definition, photosynthetic pigments, basic concept about mechanism of light-dependent and light independent reactions; C 3 -, C4 - and CAM pathways of CO_2 fixation;

Photorespiration - definition, sites, mechanism and significance

Unit 6: Plant growth regulators **(10 lectures)**

Definition and types, bioassay (auxin only), Chemical nature and physiological roles of: Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene.

Unit 7: Physiology of flowering **(8 lectures)**

Photoperiodism, flowering stimulus, physicochemical nature of phytochrome, role of phytochromes in flowering, florigen concept, vernalization;

Unit 7: Seed Physiology (6 Lectures)

Seed germination - different phases of seed germination, seed dormancy (types, significance and breaking of seed dormancy).

Practical

5. Determination of osmotic potential of plant cell sap by plasmolytic method (using *Rhoeo* epidermal peel).
6. Determination of amount of water absorption, retention and transpiration.
7. Study of the effect of humidity and light on the rate of transpiration in excised twig/leaf.
8. Study the effect of KNO_3 on stomatal opening.
9. Determination of the effect of CO_2 concentration on the rate of photosynthesis using molar solution of bicarbonate and by measurement of volume of O_2 liberation.
6. Determination of soil (a) pH, (b) Moisture Content and (c) Water Holding Capacity.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Core Course - XII

Cell Biology and Genetics

THEORY (40+10=50)

Cell Biology:

Unit1: The cell **(4 lectures)**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Unit 2: Cell wall and plasma membrane **(4 lectures)**

Chemistry, structure and function of Plant cell wall and Cell membrane. Overview of membrane function; fluid mosaic model; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Unit 3: Cell organelles **(10 lectures)**

Nucleus: Structure of nucleus, nuclear envelope, nuclear pore complex, **Mitochondria and Chloroplast:** Structural organization; functions; **Endomembrane system:** Endoplasmic Reticulum – Structure and functions of RER and SER, Signal hypothesis; **Golgi Apparatus** – organization and functions; Lysosomes; **Ribosome** – structure and function.

Unit 4: Cell division **(6 lectures)**

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints (role of cyclins and Cdks).

Genetics:

Unit 5: Mendelian genetics and its extension **(12 lectures)**

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance, concept of homozygousity, heterozygousity, Incomplete dominance and co-

dominance; Gene interactions - Epistasis, Lethal genes, Complementary genes, Inhibitory genes; Basic concept of Pleiotropy and Polygenic inheritance.

Unit 6: Linkage, crossing over and chromosome mapping (8 lectures)

Linkage and crossing over- Coupling and Repulsion hypothesis; Linkage group, types of linkages; Crossing over and Recombination - definitions. types and mechanism, Cytological basis of crossing over in plants; Recombination frequency, three point cross and linkage mapping

.

Unit 7 Numerical and structural aberration of chromosomes (8 lectures)

Structural aberrations: Deletion, Duplication, Inversion, Translocation; Non-disjunction, Robertsonian translocation and Isochromosomes, Position effect;

Numerical aberrations: Euploidy – Haploid and Monoploid, Auto and allopolyploidy, Induction of polyploidy, Significance of polyploidy; Aneuploidy – different types of aneuploids, types of trisomics.

Unit 4: Fine Structure of Gene and gene mutation mutations (10 lectures)

Classical vs molecular concepts of gene; Cis-Trans complementation test; Mutation – Definition and types, molecular basis of mutations (spontaneous and induced); Point mutations and Frame-shift mutation; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); DNA repair-mechanisms (photoreactivation and excision repair only); Transposable elements (IS element and Tn transposons), Ac-Ds elements in Maize.

Practical

1. Study of mitotic cell division and chromosome complement in *Allium cepa* by aceto-orcein squash technique.
2. Determination of mitotic index in *Allium cepa* root tip by aceto-orcin squash technique.
3. Study of meiotic division in *Allium cepa* or *Rhoeo spathacea / R. discolor* by aceto carmine staining technique.

4. Testing of goodness of fit with Mendelian mono- and dihybrid ratios.

Suggested Readings

9. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
10. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
11. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
12. Molecular Biology of the Cell – Bruce Albert
13. Molecular Biology of the Gene – Watson
14. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
15. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
16. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
17. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
18. Genes – XI (Lewin)

SEMESTER - VI

Core Course XIII: Molecular Biology

THEORY (Credit :4) = 40+10=50

Unit 1: Nucleic acids : Carriers of genetic information (6 lectures)

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

Unit 2. The Structures of DNA and RNA / Genetic Material (12 lectures)

DNA Structure: DNA structure, Salient features of double helix (As per Watson and Crick's Model), Types of DNA, Organization of genetic materials – eukaryotes, prokaryotes and of viruses; RNA - Types and Structure; Chemical nature of DNA

and RNA; Chromosome packaging in eukaryotes (nucleosome and solenoid model to metaphase chromosome); Euchromatin and Heterochromatin.

Unit 2:The replication of DNA (10 lectures)

DNA Replication – General principles, bidirectional, semi-conservative and semi discontinuous replication; Replication of linear ds-DNA, Enzymes involved in theprocess of DNA replication.

Unit 3: Central dogma and genetic code (2 lectures)

Concept of central dogma and reverse transcription; RNA world concept; Genetic code – Characteristics, evidences and deciphering of codon dictionary.

Unit 4: Transcription and post transcriptional modification (14 lectures)

Transcription in prokaryotes, Enzymes involved and process (Initiation, elongation and termination – rho dependent and rho independent), Split genes-concept, splicing – self splicing and spliceosome mediated splicing, end- modifications (5′ capping and 3′ polyadenylation).

Unit 6: Translation (8 lectures)

Protein synthesis - Charging of tRNA, initiation, elongation and termination of protein synthesis; Inhibitors of protein synthesis.

Unit 7: Gene Regulation in Prokaryotes (8 Lectures)

Operon Concept, Anabolic and Catabolic operons, Lac Operon (Negative and Positive Control), Glucose effect.

Practical

1. Isolation of chromosomal DNA from *E. Coli.*
2. Isolation of Plant DNA (CTAB method).
3. Estimation of isolated DNA by agarose gel-electrophoresis.
4. Blood Grouping

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Core Course XIV: Plant Biotechnology and Tissue Culture

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Plant Tissue Culture (16 lectures)

Historical perspective; Composition of media (General concept with respect to MS medium)); role of vitamins and hormones; Totipotency, organogenesis, embryogenesis (somatic and zygotic), protoplast isolation, culture and fusion;

Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids;

Cryopreservation; Germplasm Conservation).

Unit 2: Recombinant DNA technology (12 lectures)

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping; Cloning Vectors – plasmid vectors, phage vectors, cosmids, phagemids, YAC and BAC; Ti-plasmid based vectors (simple map and characteristics).

Unit 3:Gene Cloning (10 lectures)

Recombinant DNA, basic cloning strategy in plasmid vector, selection of recombinant clones (insertional mutagenesis and blue white screening); Southern blotting;

Construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; Probe.

PCR (polymerase chain reaction) – method and applications.

Unit 4: Methods of gene transfer (8 lectures)

Transformation, Liposome mediated gene transfer, *Agrobacterium*-mediated gene transfer, Electroporation, Microinjection, Microprojectile bombardment.

Unit 5: Applications of Biotechnology (14 lectures)

Agricultural (Flvr-Savr tomatoes by antisense RNA technology, Bt-cotton, Golden rice), Medical (Insulin and subunit vaccines) and Environmental (*Pseudomonas putida* – Chakraborty's bug) aspects of genetic engineersing.

Practical

1. Demonstration of MS Medium preparation, Aseptic culture of seed (mustard), shoot tip culture as a process of micropropagation.
2. Demonstration of Callus development using apical meristem
3. Isolation of plasmid DNA (Alkali lysis methoid)
4. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K.

5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

GENERIC ELECTIVE - I

Theory – (Marks – 40+10 = 50)
(Algae, Fungi and Bryophyta)
Algae -

General characteristics; Ecology and distribution;

Range of thallus organization and reproduction;

Classification of algae (Fritsch – 1935);

Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Zygnema*, *Vaucheria*, *Fucus*, *Polysiphonia*.

Economic importance of algae

Fungi -

Introduction- General characteristics, cell wall composition , nutrition, reproduction and classification (Gwyenne-Vaughan and Barnes, 1937)

General characteristics and life cycle of *Mucor* (Zygomycota), *Penicillium* (Ascomycota),

Agaricus (Basidiomycota) and Deuteromycetes;

Lichens: General account, reproduction and significance;

Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Bryophytes -

General characteristics, Classification (Proskauer, 1957),

Morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included).

Ecological and Economic importance of bryophytes.

Internal assessment – (10) Practical – (Marks - 20+30 = 50) Core Course: I (Practical) (Algae, Fungi and Bryophyta)

Study of following genera: *Oscillatoria, Oedogonium, Chara; Ascobolus, Agaricus; Marchantia, andFunaria***.**

Identification of all the genera included in the theoretical syllabus.

Wet specimen collection and preservation.

Internal assessment – 30

GENERIC ELECTIVE - II

Theory – (Marks 40+10 = 50)
(Pteridophyta, Gymnosperms and Palaeobotany)
Pteridophytes -

General characteristics, classification (Sporne, 1975) Early land plants (*Cooksonia* and *Rhynia*).

Morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*.

(Developmental details not to be included).

Heterospory and seed habit, stelar evolution. Economical importance of Pteridophytes.

Gymnosperms -

General characteristics,

Classification (Stewart and Rothwell, 1983),

Morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Economical importance.

Palaeobotany –

Terminologies (Palaeobotany, Palynology, Palaeofloristics, Palaeoecology, fossils, subfossil) and their definition.

Types of fossils on the basis of mode of preservation.

Geological time scale and major events of plant lives.

Internal Marks - 10
Practicals– (Marks – 20+30 = 50)

Pteridophytes – Study of stem anatomy and reproductive structure of *Selaginella*, *Equisetum* and *Pteris*

Gymnosperms - Morphoanatomical studies of *Cycas* (leaflet, rachis, microsporophyll),

Pinus (Stem, needle, male cone)

Identification includes all other genera included in the theoretic operation **Internal assessment – 30**

GENERIC ELECTIVE - III

(Marks 40+10 = 50)

(Morphology, Embryology, Plant Taxonomy and Plant Anatomy)

Morphology and Embryology –

Leaf – Types, modifications of leaf lamina, Phyllotaxy,

Stipule – Types and modifications

Inflorescences – Types with examples

Flower – Flower is a modified shoot, Morphology of different parts of a flower, Cohesion and adhesion.

Pollination and fertilization – Types and contrivances; fertilization – double fertilization/triple fusion; General structure of dicot and monocot embryo; endosperm types.

Fruits – Types with example.

Plant Taxonomy –

Introduction to plant taxonomy – Identification, Classification, Nomenclature; Definition: - Artificial, natural and phylogenetic classification; Concept of Binomial Nomenclature; Classification by Bentham & Hooker (upto series).

Functions of Herbarium and Botanical Gardens, Important Herbaria and Botanical Gardens of the world and India.

Taxonomic hierarchy – Ranks, Categories and Taxonomic Groups

Plant Anatomy –

Tissue – Meristematic and Permanent tissue, Their types; Root and shoot apical meristems; Simple and Complex Tissues

Tissue system – General idea of epidermal, vascular and ground tissue systems, Types of vascular bundles.

Organs – Primary structure of Stem, Root and Leaf.

Secondary growth – Secondary growth in typical stem and root (dicot only), Seasonal activity of cambium; Wood – heartwood and sapwood

(Practicals) (Marks 20+30 = 50)

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formulae/ and Identification): –

   Brassicaceae, Solanaceae, Malvaceae, Fabaceae, Lamiaceae, Verbenaceae, Apocyanaceae and Asteraceae

2. Anatomical study of the sections of – Stem (Sunflower and Maize), Root (Chick Pea and *Canna*) and Leaf (*Nerium*)
3. Identification of types of fruits (berry, pome, capsule, pepo, hesperidium), inflorescences (verticillastor, cyathium, spikes, hypanthodium) and stipules (Adnate, interpetiolar, intrapetiolar, free lateral and ochreate) of angiosperms.

4. Identification from permanent slides – Stomata, Cystolith, Raphides, Stone Cells and Lenticels
5. Submission - Herbarium sheets – Maximum 10 from local flora with proper labeling and field record
6. **Internal assessment – 30**

GENERIC ELECTIVE - IV

(Marks - 40+10 = 50)

Plant Physiology, Metabolism and Ecology-

Plant-water relations, Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Mineral nutrition- Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements;

Translocation in phloem - Composition of phloem sap, General idea about Phloem loading and unloading.

Photosynthesis – Light Reaction (Photosynthetic Electron transport System and mechanism of ATP synthesis); Outline of C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Respiration – Introduction, Glycolysis, Oxidative decarboxylation and TCA cycle; Oxidative phosphorylation.

Enzymes - Definition and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Nitrogen metabolism - Biological nitrogen fixation – symbiotic and asymbiotic examples, mechanism of symbiotic N_2 fixation.

Plant growth regulators - Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Ecology –

Definition – Autecology and Synecology; Concept of energy flow; Food chain and food web.

Ecological pyramids – pyramids of biomass, energy and numbers.

Ecological Succession - Hydrosere

Ecological adaptations and adaptive characteristics of hydrophytes, xerophytes and halophytes

Phytogeography – Phytogeographical classification of India (D. Chatterjee, 1962); Concept of endemism.

Pollution – Air and water – Causes, effects and Remedies.

(Practicals) (Marks 20+30 = 50)

Determination of isotonic concentration of cell sap by plasmolytic method.

To find the essentiality of CO2 in photosynthesis using *Hydrilla/ any other* aquatic plant. To study the effect of two environmental factors (light and humidity) on transpiration using *Colocasia* leaf.

Comparison of the rate of respiration in any two parts of a plant.

Study of the anatomical adaptations of xerophytes (*Casuarina* stem) and hydrophytes (*Anhydra* stem)

Internal assessment – 30

Skill Enhancement Course

(For Botany Honours)

SEC – 1: BIOFERTILIZERS

Unit-1: General account about the microbes used as biofertilizer.

Rhizobium – isolation, identification, mass production, Commercialization. (6 lectures)

Unit -2: General idea about Plant growth promoting rhizobacteria (PGPR) and Phosphate solubilizing bacteria (PSB) (6 lectures)

Unit- 3: Cyanobacteria (blue green algae) and Azolla as biofertilizer; Blue green algae and Azolla production.(6 lectures)

Unit -4: Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution; VAM fungi, and their influence on growth and yield of crop plants. (6 lectures)

Unit -5: Organic farming – Green manuring and organic fertilizers; Organic Compost and Vermicompost - production and application. (6 lectures)

Suggested Readings -

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.

2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.

3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.

4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.

5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.

6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

OR

SEC – 1: ETHNOBOTANY

Unit 1: Ethnobotany Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context. (6 Lectures)

Unit 2: Methodology of Ethnobotanical studies a) Field work b) Herbarium c) Ancient Literature. (6 lectures)

Unit 3: Role of ethnobotany in modern Medicine; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Aloe vera*. d) *Eclipta alba* e) *Phyllanthus niruri* f) *Emblica officinalis* g) *Centella asiatica* h) *Saraca indica*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina*, *Taxol brevifolia*, *Artemisia vulgaris*, *Withania somnifera*. (10 lectures)

Unit 4: Ethnobotany and legal aspects - Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge. (8 lectures)

Suggested Readings

1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.

2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981

3) Lone et al,. Palaeoethnobotany

4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, - Lucknow, India.

5) S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.

6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – - Chichester

7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah.

8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996

9) Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd. 84

SEC – 2: PLANT DIVERSITY AND HUMAN WELFARE

Unit -1: Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa. Values and uses of Biodiversity: Ethical and aesthetic values. (8 lectures)

Unit -2: Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss. (6 lectures)

Unit -3: Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservation. (6 lectures)

Unit-4: Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. (10 lectures)

Suggested Readings 1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

OR

SEC – 2: MUSHROOM CULTURE TECHNOLOGY

Unit 1: Introduction and history. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*; Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.. (5 Lectures)

Unit 2: Methods of cultivation of edible mushrooms. Diseases of Mushroom fungi and methods of remedy (12 Lectures).

Unit 3: Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. (8 Lectures)

Unit 4: Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value. (5 lectures)

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.

4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

SEM - V

DSE – 1

Analytical Techniques in Plant Sciences

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Imaging and related techniques (10 lectures)

Basic Principles of - Light microscopy, Phase-contrast microscopy, SEM and TEM.

Unit 2: Cell fractionation (10 lectures)

Basic Principle of Centrifugation: Differential and density gradient centrifugation.

Unit 3: Radioisotopes (10 Lectures)

Use of radioisotopes in biological research, auto-radiography, pulse chase experiment

Unit 4: Colorimeter and Spectrophotometry (10 Lect)

Basic Principle and its application in biological research.

Unit 5: Chromatography (10 Lectures)

Basic Principles and application in brief of - Paper chromatography, Column chromatography (Gel filtration, Ion-exchangeand Affinity chromatography), Gas Chromatography

Unit 6: Electrophoresis (10 lectures)

Basic principle and application of agarose gel and poly acryl amide gel electrophoresis (native PAGE and SDS-PAGE).

Practical

1. Separation of amino acids by paper chromatography and identification of unknown sample.
2. Preparation of permanent slides (double staining) for microscopic studies of any plant tissue.

3. Demonstration of some Instruments: Centrifuge, Colorimeter/Spectrophotometer and Electrophoresis.

Suggested Readings

4. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
5. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
6. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
7. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

DSE – 1

Bioinformatics

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit I: (14 lectures)

Introduction to bioinformatics and data generation What is bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, RDP), databases (GENBANK, Pubmed, PDB) and software(UniproUGENE, MEGA 6, RASMOL, Primer 3

Unit II: (12 lectures)

Biological Database - General Introduction of Biological Databases; Nucleic acid databases (DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary).

Unit III: (10 lectures)

Data storage and retrieval of Flat files, File Format (Genbank, FASTA, PDB, SwissProt)

Unit IV: (14 lectures)

Sequence Alignments and Visualization - Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).

Unit V: (10 lectures)

Applications of Bioinformatics - phylogenetic analyses, primer designing, drug desingning.

Practical

3. Using BLAST to search for an unknown gene.
4. 16S rDNA sequence retrieval from BLAST and RDP.
5. Sequence alignment using Mega6 or UGENE
6. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

DSE – 2

Stress Biology

Credits: Theory 4, Practical 2

Lectures:60

Theory

Unit 1: Plants response to stress **(16 lectures)**

Types of stresses – biotic and abiotic; Biotic stress- stress to pathogenesis; Abiotic stress – Droght, chilling and salt stresses (Effects of these stresses and mechanism of their tolerance)

Unit 2: Mechanism **(16 lectures)**

Cell signalling and molecular response to salt tolerance; Mechanism of hypersensitive response (HR)and systemic acquired resistance (SAR)

Unit 3: Developmental and physiological mechanisms that protect plants against environmental stress **(14 lectures)**

Adaptation in plants to different stresses; Changes in root: shoot ratio; Compatible solute production.

Unit 4: **(14 lectures)**

Generation of Heat shock proteins and Reactive oxygen species– their role and management.

Practical

1. Detection of stress related compatible solutes viz. proline by colorimeter/spectrophotometric method in a plant under salinity stress.
2. Measurement of root:shoot ratio, and total wet weight of a plant under salt/drought stress
3. Effect of salt/temperature stress on seed viability and germination.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

DSE – 2

Plant Breeding

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Plant Breeding **(10 lectures)**

Introduction, aims and objectives of plant breeding; Plant introduction, acclimatization and domestication.

Unit 2: Methods of crop improvement (20 lectures)

Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 3: Quantitative inheritance (10 lectures)

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings.Monogenic vs polygenic Inheritance.

Unit 4: Inbreeding depression and heterosis (10 lectures)

History, genetic basis of inbreeding depression and heterosis;
Applications.

Unit 5: Crop improvement and breeding (10 lectures)

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical –

1. Calculation of central tendency – mean, mode and median of a data obtained from natural population.
2. Normal distributon curve using a continuous variation (Data May be provided).
3. Chi square test of goodness of fit for Mendelian ratios.
4. Demonstration of Breeder's kit.

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.

SEM- VI

DSE – 3

DSE – 2 (Program)

Natural Resource Management

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Natural resources **(2 Lectures)**

Definition and types.

Unit 2: Sustainable utilization **(8 Lectures)**

Concept, approaches (economic, ecological and socio-cultural).

Unit 3: Land **(8 lectures)**

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4: Water **(8 lectures)**

Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 5: Biological Resources **(12 lectures)**

Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR (Intellectual Property Rights); CBD (Concservation of Biological Diversity); National Biodiversity Action Plan).

Unit 6: Forests **(6 lectures)**

Definition, Cover and its significance (with special reference to India); Major and minor forestproducts; Depletion; Management.

Unit 7: Energy **(6 lectures)**

Ren ewable and non renewable sources of energy, Biomass and energy; Biofuel

Unit 8: Contemporary practices in resource management (8 lectures)

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management

Practical

1. Project work and Report Submission.
2. Viva on the project done.

Suggested Readings

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

DSE – 3

Horticultural Practices and Post-Harvest Technology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Introduction (4 lectures)

Scope and importance, Branches of horticulture; Role in rural economy.

Unit 2: Ornamental plants (4 lectures)

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, tuberose], Ornamental flowering trees (Gulmohar, Lagerstroemia and areca palms).

Unit 3: Fruit and vegetable crops **(4 lectures)**

Description of plants and their economic products; Management and marketing of vegetable (Potato and Brinjal) and fruit crops (Mango and Banana).

Unit 4: Horticultural Practices **(8 lectures)**

Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Bonsai Production.

Unit 7: Post-harvest Technology **(10 lectures)**

Harvesting and handling of fruits, vegetables and cut flowers.

Unit 9: Tissue culture **(10 lectures)**

Role of micropropagation and tissue culture techniques in horticultural crops.

Practicals

1. Methods of Vegetative propagation – Cuttings, grafting, gooting and layering.
2. Disease Management – Integrated Pest Management practices (A field study).
3. Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at IARI or other suitable locations.

Suggested Readings

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

DSE – 4

Research Methodology

Credit: Theory 4; Practical 2

Lectures: 60

Theory

Unit 1: Basic concepts of research **(12 lectures)**

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs emperical); Literature-review and preparation of References.

Unit 2: General laboratory practices **(12 lectures)**

Preparation of solutions - Percentage solutions, Molar, Molal and Normal solutions; Method of Dilution; Safety measures in handling Toxic Chemicals.

Unit 3: Data collection and documentation of observations **(6 lectures)**

Maintaining a laboratory record; Tabulation and generation of graphs.

Unit 4: Overview of Biological Problems **(10 lectures)**

Key biology research areas, Model organisms in Biological Research (A Brief overview about *E. Coli*, Yeasts and *Arabidopsis*).

Unit 5: **Methods to study plant cell/tissue structure** **(10 lectures)**

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning.

Unit 6: Plant microtechniques **(10 lectures)**

Staining procedures – Methods of single and double staining.

Practical

1. Praparation of normal (N), molar (M) and percent (%) solution of Sucrose.
2. Plant microtechnique experiments – Staining Techniques.
3. Poster presentation on defined topics.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

DSE – 4

Industrial and Environmental Microbiology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Scope of microbes: In industry and environment. **(12 lectures)**

Unit 2: Microbial production of industrial products **(16 lectures)**

Microorganisms involved, media, fermentation conditions for the production of Enzyme: (amylase), Organic acid (citric acid), alcohol (Ethanol) and antibiotic (Penicillin).

Unit 3: Microbial flora of water. **(20 lectures)**

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality.

Unit 4: Microbes in agriculture and remediation of contaminated soils. **(12 lectures)**

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils.

Practical

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Isolation and enumeration of microorganisms from soil, air and water.

Suggested Readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

DSE – 4

Biostatistics

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1:Biostatistics **(12 lectures)**

Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

Unit 2:Collection of data primary and secondary **(12 lectures)**

Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

Unit 3:Measures of central tendency **(14 lectures)**

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

Unit 4:Correlation **(12 lectures)**

Types and methods of correlation, regression, simple regression equation.

Unit 5:Statistical inference **(10 lectures)**

Hypothesis - simple hypothesis - student 't' test - chi square test.

Practical

1) Calculation of mean, standard deviation and standard error mean
2) Calculation of correlation coefficient and regression values.
3) Interpretation of a continuous variation by a binomial curve with a given value of mean and standard deviation.

Suggested Readings

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.

2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore

3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press. 4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.

5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.

6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.