Ch. Charan Singh University, Meerut Campus
M.Sc. Botany (Choice Based Credit System) Syllabus
Effective from session 2016-17 **Revised on 13.03.2018**
Distribution of marks in different courses

I Semester	Course Title	Credits	Total Marks (Int.+Ext.)
Core Compulsory Theory I/CH-1501	Phytotechniques and Biostatistics	4	40+40
C.C.T II/CH-1502	Microbiology	4	40+40
C.C.T III/CH-1503	Algae and Bryophytes	4	40+40
C.C.T IV/CH-1504	Taxonomy of Angiosperm and Economic Botany	4	40+40
C.C.Practical -I (4 Hours) CH-501	Based on Courses I-IV	2+2+2+2	80
Open Elective I: CO-56 - - - - -	Self- Study-1A. Hindi/B. English/C. Urdu/D. Sanskrit	4	100
	Total Credits/marks	**28**	**500**

II Semester	Course Title	Credits	Total Marks
C.C.T V/CH-2501	Mycology and Plant Pathology	4	40+40
C.C.T VI/CH-2502	Pteridophytes, Gymnosperms and Palaeobotany	4	40+40
C.C.T VII/CH-2503	Molecular Biology and Biotechnology	4	40+40
C.C.T VIII/CH-2504	Cell Biology & Genetics	4	40+40
C.C.P II (4 Hours) CH-601	Based on Courses V-VIII	2+2+2+2	80
Open Elective II CO-6610	Disaster Management	4	100
	Total Credits/marks	**28**	**500**

III Semester	Course Title	Credits	Total Marks
C.C.T IX/CH-3501	Plant Water relations; Growth and Development	4	40+40
C.C.T X/ CH-3502	Phytochemistry and Metabolism	4	40+40
C.C.T XI/ CH-3503	Anatomy and Reproduction in Angiosperms	4	40+40
C.C.T XII/CH-3504	Plant Ecology and Phytogeography	4	40+40
C.C P III (4 Hours) CH-701	Based on theory courses IX-XII	2+2+2+2	80
Open Elective III: CO-7610	Environmental Awareness	4	100
	Total Credits/marks	28	500

Specializations	IV Semester	Course Title (Core Elective Courses (Any Set of two courses each, for 2 specializations) CET -I to CET-VII	Credits	Total Marks
C.E.T-I Plant Biotechnology	Course XIII / CH-4501	A. Recombinant DNA technology	4	40+40
	Course XIV / CH-4502	A. Plant Tissue Culture	4	40+40
C.E.T. II. Microbial and Environmental Biotechnology	Course XV / CH-4503	B. Microbial Biotechnology	4	40+40
	Course XVI / CH-4504	B. Environmental Biotechnology	4	40+40
C.E .T.III. Applied and Stress Physiology	Course XIII / CH-4505	C. Stress Physiology of Plants	4	40+40
	Course XIV / CH-4506	C. Applied Plant Physiology	4	40+40
C.E.T.IV Medicinal Botany	Course XV / CH-4507	D. Pharmacognosy	4	40+40
	Course XVI / CH-4508	D. Post -Harvest technology of medicinal plants	4	40+40
C.E.T. V Plant Genetic Resources and Conservation	Course XV/ CH-4509	E. Plant Genetic Resources and economic Botany	4	40+40
	Course XVI/ CH-4510	E. Biodiversity conservation and Plant Resources	4	40+40
C.E. T.VI. Applied Plant Pathology	Course XV/ CH-4511	F. Applied Mycology	4	40+40
	Course XVI/ CH-4512	F. Molecular Plant Pathology	4	40+40
C.E. T. VII Computer Science, Genomics & Bioinformatics	Course XIII/ CH-4513	G. Elementary Computer knowledge and Bioinformatics	4	40+40
	Course XIV/ CH-4514	G. Genomics for Plant improvement	4	40+40
C.C.P. IV (4 hours)	Practical/Project based on two sets of Core Electives / CH-801	Based on theory courses XIII-XIV, XV-XVI	2+2+2+2	80
Open Elective 4:	Self-Study 4 CO-8610	Intellectual Property Rights/ Project/ Courses provided by other departments	4	100
		Total Credits/marks	28	500
		Grand Total Credits/marks	112	2000

A candidate can select any two sets of elective courses from XIII to XXVIII (as per availability in the institution) to serve as specialization (s). Each core (compulsory and elective) course will

have 4 hours theory and 4 hours practical in each week, equaling 4+2=6 credits. In each semester there will be one open elective of 4 credits each. A minimum of 108 credits are required to be earned for successful completion of the Master's degree including a minimum of 72 credits of Core Compulsory, 24 credits of Core elective and 12 credits of open elective courses.

All regulations of CBCS courses as provided by the University ordinances and modified from time to time will become effective from the given dates.

A minimum of 30% marks separately in internal and external assessment of each course and an aggregate of 40% marks in all the courses (including practical) is required for passing. In case of failing to obtain 30% marks in internal assessment of any paper, the candidate will not be eligible to appear in external examination of that course.

Every student will be given two specializations based on qualifying the optional sets of papers (Core electives) in 4th semester.

Internal assessment will be based on :

Quizzes -2: (from first Unit) Each for 5 marks

Tests-2: for 10 marks each (based on 2 units each)

Seminar/ Term Paper: 10 marks in each paper

Eligibility for admission to the course: B.Sc (Bio)/B.Sc. (CBZ)/B.Sc. (Life Sc.)/Hons. with minimum 55% marks and Intermediate with minimum second division (45%) or with 50% aggregate marks in B.Sc and Intermediate both. In the subject itself minimum 50% marks are necessary for eligibility.

CBCS Regulations and grade card as per University Ordinance will be followed with any changes introduced here after.

CH-1501 Phytotechniques and Biostatistics 50 Hours

Unit I 10 Hours

Basic Botanical techniques:

1 Different types of stains, their preparation and uses: Safranin, fast green, hematoxylin, iodine, cotton blue, crystal violet, ruthenium red, Janus green, Gram's stains, Acetocarmine

2 Microscopy: Principle, parts and functioning of electron microscopes including stereoscopic binocular, dark field illumination, confocal, phase contrast, fluorescence and polarizing microscopes, camera lucida, SEM, TEM. STEM.

3. Microtomy: dehydration, clearing and embedding of material, section cutting, dewaxing.

4. Collection and preparation of herbarium sheets; preservation and storage of plant materials

Unit II 10 Hours

Biophysical methods

5. Instrumentation, principle and Methods of fractionation- Cell sorting, Chromatography, Electrophoresis, Centrifugation, X- ray diffraction

Unit III 10 Hours

Methods of quantitative analysis-

6. Spectrophotometry, MS, NMR, ESR, ORD/CD spectrometers,
7. Radioisotopic methods: Geiger Muller & Liquid Scintillation Counters.
8. Immunological methods: immunodiffusion, immuno- electrophoresis, crossed immuno-electrophoresis, counter- RIA, ELISA , Immunoblotting

Unit IV 10 Hours

Statistical methods

9. Classification and presentation of data, , graphical presentation: frequency polygon and curve, &cumulative frequency curve. Distribution
10. Measures of Central tendency: mean, mode, median and their properties .
11. Measures of dispersion: Mean deviation, standard deviation and coefficient of variation.

Unit IV 10 Hours

11. Simple correlation, coefficient and regression,
12. Principle of experimental designs, randomized block and Latin square designs and Analysis of Variance (ANOVA).
13. Tests of significance, t-tests, X^2 test for goodness of fit.

CH-1502 **Microbiology** **50 Hours**

Unit – I **10 Hours**

1. Development of microbiology as science, important contribution of pioneer microbiologists; golden era of microbiology.
2. Isolation, purification and cultivation of microbes from soil, water and air.
3. Important criteria used for classifications of microorganisms (morphological, ecological, biochemical, molecular and numerical).

Unit – II **10 Hours**

Bacteria:

4. Classification of bacteria based on Bergey's manual of determinative bacteriology.
5. Archaebacteria and Eubacteria: Characters, Ultrastructure, nutrition, genetic recombination (Transformation, Transduction, Conjugation), and economic importance.
6. Cyanobacteria: salient features, biological and economic importance.
7. **Phytoplasma**: General characteristics, structure, reproduction and role in causing plant diseases.

Unit – III **10 Hours**

Virus:

8. Biological nature, characteristics and ultrastructure of Plant (TMV, Polaro, Papaya Mosaic Virus), animal (retro viruses and hepatitis B virus)and bacterial virus (T4 ϕphi X174, M13), replication, transmission and economic importance of viruses.
9. Structure, reproduction and importance of viroids, virusoids, prions

Unit – IV **10 Hours**

10. **Host-parasite interaction**: a brief idea of recognition and entry process of bacteria, viruses into animal & plant-host cells, alteration of host cell. Virus induced cancer; bacteria and plant two- component signaling systems; bacterial chemotaxis and quorum sensing. Hormones and their receptors, signaling through G–protein coupled receptors, regulation of signaling pathways.
11. **Innate and adaptive immune system**: Types of Immunity, antigens, antigenicity, structure and function of antibody molecules, monoclonal antibodies, Antigen-antibody interactions (serology), activation & differentiation of B and T Cell, B & T cells receptors, MHC molecules compliment system, immune response during bacterial (tuberculosis), parasitic (malaria) and Viral (HIV) infections, vaccine.

Unit – V **10 Hours**

12. Distribution of microbes in air, water, soil and human body.
13. Microbes for control of pollution.
14. Microbial enzymes and their applications.
15. Microbes in nanobiotechnology.

CH-1503 Algae and Bryophytes 50 Hours

Unit – I 10 Hours

Algae:

1. Classification and salient features of different classes of Algae.
2. Algal cell biology.
3. Algal pigments, food reserves, flagellation and their importance in classification.
4. Major contributions of algologists in India.
5. Thallus organisation, reproduction and life cycle patterns.
6. Economic importance of algae as food, feed, source of chemicals and drugs, Bioenergy, Algal biofertilizers, industrial uses.
7. Algae as source of bioremediation, bioindicator (algal blooms),

Unit – II 10 Hours

8. Comparative study of classes of Chlorophyceae, Xanthophyceae and Bacillariophyceae, with help of diagram:

a. Range of thallus organization including ultrastructure.
b. Methods of reproduction.
c. Variation in life cycles.
d. With special reference to *Hydrodictiyon, Pithophora, Ulva, Cosmariun, Bryopsis* and *Stigeoclonium*.

Unit – III 10 Hours

10. Comparative study of Phaeophyceae and Rhodophyceae with reference to:
    a. Range of thallus organization.
    b. Method of reproduction.
    C. Variation in life cycles.

Unit – IV 10 Hours

Bryophytes:

11. Classification of Bryophytes and their distribution in India.
12. Range of thallus structure (plant body) and anatomy in Bryophytes (with suitable examples)
13. A general account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.
14. Major contribution of bryologist in India.

Unit – V 10 Hours

15. Evolutionary tendencies in sporophytes of Bryophytes (Progressive sterilization of sporogenous tissue)
16. Reproduction, life history, Inter-relationship, affinities of various groups of Bryophytes.
17. Ecology and economic importance of Bryophytes.

CH-1504 Taxonomy of Angiosperms and Economic Botany 50 Hours

Unit- I 10 Hours

Taxonomy of Angiosperms:

1. History of plant Taxonomy.
2. International Code of Botanical Nomenclature (ICBN). Salient feature, important rules and recommendation, Binomial nomenclature, botanical gardens and herbaria.
3. Taxonomic evidences: Morphology, Plant anatomy, Palynology, Embryology, Cytology, Phytochemistry, Genome analysis and DNA hybridization technique in relation to taxonomy, numerical taxonomy, serotaxonomy.

Unit- II 10 Hours

4. The species concept: Taxonomic hierarchy, species, genus, family and other categories, Principles used in assessing relationship, delimitation of taxa and attribution of rank. Variation and specialization in plants.
5. Phylogenetic systems of classification: Hutchinson, Cronquist, Takhtajan and Dahlgren. Outlines, merits and demerits.
6. Basic knowledge of phylocode and A P G system.

Unit- III 10 Hours

7. Range of floral structure and phylogeny in:

I. **Dicotyledons:**

a. Magnoliidae with special reference to Magnoliaceae, Capparidaceae, Piperaceae,
b. Hamamelidae with special reference to Moraceae, and Casuarinaceae,
c. Caryophyllidae with special reference to Cactaceae, Chenopodiaceae and Polygonaceae,
d. Dilleniidae with special reference to Tiliaceae, Sterculiaceae, Violaceae,
e. Rosidae with special reference to Lythraceae, Combretaceae,
f. Asteridae with special reference to Boraginaceae, Scrophulariaceae, Bignoniaceae

Unit- IV 10 Hours

II. **Monocotyledons:**

a. Alismatidae,
b. Commelinidae with special reference to Commelinaceae and Zingiberaceae,
c. Arecidae with special reference to Araceae,
d. Liliidae with special reference to Amaryllidaceae
e. Orchidaceae

Unit- V 10 Hours

Economic Botany:

8. Botanical names, families, Plant part(s) used and uses of the economically important plants
   belonging to following categories:
   Fiber plants; Spices and condiments; Beverages; Medicinal plants;
   Non-wood plant products (NWPPs): rubber, dyes, resin, gums etc.

CH-2501 Mycology and Elementary Plant Pathology 50 Hours

Unit – I 10 Hours

1. General characters of fungi, and range of thallus organization in fungi.
2. Types of reproduction in fungi.
3. Unique aspects of (i) fungal cells, (ii) molecular biology of fungi
4. Classification of fungi as proposed by Ainsworth (1973) Alexopoulus, Mims& Blackwell (1996), Hibbet *et al.* (2007). Recognition of Fungi as a separate kingdom; splitting of the fungi (Fungi and allied organisms into three kingdoms- Protista, Chromista and Fungi.
5. Nutrition and growth in Fungi including factors affecting fungal growth.
6. Differentiation in fungi: control of i) Dimorphism. ii) conidiation. iii) mating (with the help of Sex hormones).
7. Heterothallism, Heterokaryosis, parasexuality and physiological specialization in Fungi.

Unit – II 10 Hours

8. A general account and affinities of the following groups with special reference to systematic position, structure and reproduction of organisms mentioned hereunder:

I. The Fungi belonging to kingdom Protozoa:

a. Myxomycota (myxomycetes): *Stemonites, Ceratiomyxa*,
b. Plasmodiophoromycota (Plasmodiophorales) *Plasmodiophora*.

II. The Fungi belonging to Kingdom Chromista: *Saprolegnia, Phythium, Phytopthora, Albugo*,

III. The Kingdom Fungi:

a. Chytridiomycota: *Synchytrium*,
b. Blastocladiomycota: *Allomyces, Coelomomyces*
c. Zygomycota: *Saksanaea, Pilobolus, Entomophthora*
d. Ascomycota : *Taphrina, Phyllactinia, Erysiphae, Neurospora, Peziza*
e. Basidiomycota: *Puccinia, Uromyces, Hemiliea, Melampsora, Tilletia, Ustilago*
f. Anamorphic fungi (Deuteromycotina): With reference to their telomorph, also wherever possible; *Cercospora, Helminthosporium, Curvularia, Alternaria, Fusarium, Colletotrichum, Aspergillus, Penicillium*.

Unit – III 10 Hours

9. Fungal interactions: I. Role of antibiotics, hyphal interference,II. Mycoparasitism, III. Commensalism, Mycorrihizae, Lichens (Structure, types, reproduction, importance),
10. Symptoms of fungal, bacterial and viral plant diseases.
11. Causes of plant diseases.
12. Host-parasite relationship, role of enzymes and toxins in disease development.
13. Effect of infection on physiology of host.
14. Effect of environment on disease development-epiphytotics, plant disease forecasting

Unit – IV 10 Hours

15. Disease control by Physical methods, chemical methods, crop rotation, plant quarantines, resistance
18. Integrated pest management mechanism, its advantages, disadvantages and future prospects.

19. Principles of biological control of air- borne and soil-borne plant diseases. Fungi as biocontrol agents of air borne and soil borne plant diseases (antibiosis, hyphal interference and mycoparasitism)

Unit – V **10 Hours**

20. Etiology and control of the following crop diseases:

Paddy	: Paddy blast, Bacterial leaf blight.		
Wheat	: Black Stem rust, Bunt of wheat, Flag smut.		
Jowar	: Grain Smut.	Sugarcane	: Smut, Red rot.
Cotton	: Wilt	Grape	: Downy and powdery mildew
Apple	: Apple scab	Groundnut	: Tikka disease.
Fibre	: Rust of *Linum*	Coriander	: Gall of coriander.

CH-2502 Pteridophytes, Gymnosperms and Palaeobotany 50 Hours

Unit – I 10 Hours

Pteridophytes:

1. Classification of Pteridophytes; specific characters of important classes.
2. Salient features, comparative organography, systematics, reproduction and Phylogeny of the following:
   a. Psilopsida: Psilophytales (*Rhynia, Horneophyton*) and Psilotales (*Psilotum, Tmesipteris*).
   b. Lycopsida: Protolepidodendrales (*Protolepidodendron*), Lepidodendrales (*Lepidodendron, Stigmaria*), Lepidospermales (*Lepidocarpon*) and Isoetales (I*soetes*).
   c. Sphenopsida: Hyeniales (*Calamophyton*), Sphenophyllales (*Sphenophyllum*) and Calamitales (*Calamites*).
   d. Pteropsida: Coenopteridales — A general account. Ophioglossales (*Ophioglossum, Botrychium*), Marattiales (*Marattia, Angiopteris*), Osmundales (*Osmunda*), Filicales (*Cyathea, Dryopteris, Pteridium*), Marsileales (*Marsilea*), Salviniales (*Salvinia*, *Azolla*) and Indian Fossils.

Unit – II 10 Hours

3. Telome concept.
4. Stelar system and evolutionary tendencies.
5. Heterospory and evolution of seed habit.
6. Apogamy, apospory, parthenogenesis.
7. Soral evolution in Pteridophytes.
8. Alternation of generations.

Unit – III 10 Hours

Gymnosperms:

9. Classification and distribution of gymnosperms with special reference to India. Study of morphology, structure and life history as illustrated by the following:Pteridospermales: Palaeozoic and Mesozoic group with reference to Lyginopteridaceae (*Lyginopteris*), Medullosaceae (*Medullosa*), Glossopteridaceae and Caytoniaceae.
10. Bennettitales: Cycadeoidaceae, Williamsoniaceae, Wielandiellaceae.
11. Cycadales: A detailed account including distribution *of living* Cycads.
12. Pentoxylale*s: A gene*ral account.
13. Cordaitales: A general account of Cordaitaceae and Poroxylaceae.
14. Ginkgoales: *Ginkgo*.
15. Coniferales: *Abies*, *Cupressus, Podocarpus* and *Araucaria*.
16. Taxales: A general account.
17. Ephedrales, Welwitschiales and Gnetales: A general account.

Unit – IV 10 Hours

18. Evolutionary tendencies in Gymnosperms.
19. Economic importance of Gymnosperms.

Unit – V **10 Hours**

Paleobotany:

20. Geological areas and distribution of plants in geological time scale.
21. Types of Fossils, Process of fossilization and fossil preservation methods.
22. Techniques of study of fossils.
23. Distribution of fossils in India

CH-2503 Molecular Biology and Elementary Biotechnology 50 Hours

Unit – I 10 Hours

1. Nucleic Acids: Nature, Structure, Conformational analysis of DNA and RNA, (t-RNA, micro-RNA), DNA replication (Origin and fork) and its biosynthesis, transpositions and mechanisms of transposition
2. Protein Synthesis: mechanism of protein synthesis in prokaryotes and eukaryotes, transcription, RNA processing, translation and regulation of protein synthesis in prokaryotes (Structural, regulatory genes and operon model), Ubiquitin targeted proteolysis.
3. Control of gene expression at transcription and translation level: Regulation of gene expression in phages, viruses, prokaryotes and eukaryotes, role of chromatin in regulating gene expression and gene silencing

Unit – II 10 Hours

4. Definition, Basic concepts, Principles and scope of Biotechnology.
5. Recombinant DNA technology, basic concept in genetic engineering, tool and techniques of recombinant DNA technology.
6. Enzymology of genetic engineering: Restriction enzymes, DNA ligase, Polymerase etc.
7. Cloning vehicles: Plasmids, Cosmids, Lambda phage, Charon phage, shuttle vectors, 2μ DNA plasmids, yeast plasmids, M13 vector.

Unit – III 10 Hours

8. Gene cloning: principles and techniques, choice of vectors, DNA synthesis and sequencing, Analysis and expression of cloned genes in host cells, RAPD, RFLP, AFLP
9. Gene libraries: mRNA isolation, cDNA synthesis, cloning and amplification of gene libraries, Genomic DNA libraries, techniques of gene mapping and chromosome walking.

Unit – IV 10 Hours

10. PCR: Principles, techniques and modification, Gene cloning vs PCR; Uses and applications of PCR.
11. Preparation of molecular probes and their uses. Labelling of probes, radioactive vs non-radioactive, techniques used in probing DNA, RNA and protein electrophoresis. Blotting techniques, DNA finger printing, gene therapy, genetic counselling.

Unit – V 10 Hours

12. Transgenic (Genetically modified) Plants: Genetic engineering of plants, Aims, strategies for development of transgenic plants (with suitable examples),
13. *Agrobacterium* – the natural genetic engineer, T-DNA and transposon mediated gene-tagging, chloroplast mediated transformation and its utility,

CH-2504 **Cell Biology and Genetics** **50 Hours**

Unit – I **10 Hours**

1. The Dynamic cell: Structural organization of plant cell, specialized plant cell.
2. Cell envelopes: Ultra-structure, chemical foundation and functions of cell wall, Biological membranes with special emphasis on plasma membrane and tonoplast membrane.
3. Plant Cell inclusions, their structure and function; Mitochondria, Chloroplast, Ribosome, Dictyosomes, Lysosomes, ER, Microbodies and Plasmodesmata.

Unit – II **10 Hours**

4. Nucleus & Nucleolus: Structure, nuclear pores, nucleosome concept.
5. Chromatin Organisation: Chromosome structure and composition, Centromere, Telomere, Euchromatin and Heterochromatin, Karyotypes, Polytene, Lamp brush chromosomes and Sex chromosomes.
6. Structural aberrations of chromosomes Deficiency, duplication (meiotic pairing & phenotypic effects), Inversions, translocations, (meiotic pairing, Chromosome disjunction), multiple translocations.
7. Numerical changes in chromosomes and Haploidy

a) Euploidy/Polyploidy: Classification, production, role in evolution, utility in crop improvement.

b) Aneuploidy : Trisomics, tetrasomics, monosomy, multisomy- meiotic behaviours, breeding behaviour.

Unit – III **10 Hours**

8. Mendel's Laws of inheritance and modified ratios.
9. Allelic and non- allelic interaction of genes.
10. Multiple alleles: alleles, coat colour in rodents, blood groups in Humans, self-incompatibility

Unit – IV **10 Hours**

11. Linkage and crossing over: chromosome mapping, linkage groups, mechanism of chromosome pairing and synaptonemal complex.
12. Sex determination in plants.
13. Maternal effects and Extra- nuclear inheritance.
14. Cell cycle & Apoptosis: Biochemical and genetic mechanism and significance
    a) Irregularities in Mitosis and
    b) Programmed Cell Death (PCD).
    c) Cytoskeleton with emphasis on spindle apparatus, motor movements.

Unit- V **10 Hours**

15. Apomixis: Cytogenetic basis and types of Apomictic reproduction
16. Mutation: Types of mutations, spontaneous and induced mutations, Physical and chemical mutagens, gene mutations, induction and detection of mutation, mutation by

transposons.

17. Concept of gene: gene structure and expression; gene fine structure, cis-trans test, Biochemical genetics, introns.
18. Genetic Code: Discovery, Properties and cracking of genetic code.

CH-3501 Plant-Water Relations & Growth and Development 50 Hours

Unit – I 10 Hours

Soil - water-plant relations:

1. Functional aspects of plant cell structure: colloidal systems, Water as a universal solvent, pressures and potentials.
2. Active and passive absorption of water. Factors affecting water absorption
3. Role of micro and macro mineral nutrients, their physiological functions and deficiency symptoms, Hydroponics.
4. Mechanism of ion (mineral) absorption. Factors affecting mineral absorption.

Unit – II 10 Hours

5. Driving forces and resistances in transpiration; stomatal movement mechanism.
6. Ascent of sap, Translocation of solutes in plants; sensor- regulator system, sucrose sensing mechanism.
7. Stress Physiology: Plant response to biotic and abiotic stress, mechanism of stress tolerance, HR and SAR, water deficit and drought resistance mechanism of salinity, metal toxicity, freezing heat and oxidative stress resistance,

Unit – III 10 Hours

Growth & Development:

8. Discovery, chemical structure, physiological role, mechanism of action, bioassay and practical applications of following plants hormones:

a. Auxins
b. Gibberellins
c. Cytokinins

9. Hormone receptors, cell signaling and Signal transduction

Unit – IV 10 Hours

10. Elementary idea of structure and functions of ABA, Ethylene, Ascorbic Acid, Brassinosteroids, Polyamines, Jasmonic acid and Salicylic acid.
11. Sensory photobiology: detection structure, chemistry, physiology, function and mechanism of action of phytochromes, cryptochromes and phototropins.
12. Photoperiodism; Photoinduction and vernalization, Role of florigen, vernalin, phytochrome and C/N ratio in flowering.

Unit – V 10 Hours

13. Dormancy: Dormancy of seeds and buds, gene expression during dormancy.
14. Seed germination and seedling growth, metabolism of nucleic acid, mobilization of reserved food material, hormonal control of seedling growth, gene expression during seedling growth.
15. Endogenous rhythms
16. Plant movements
17. Ageing and Senescence

CH-3502 **Phytochemistry and Metabolism** **50 Hours**

Unit- I **10 Hours**

Energy flow:

1. Fundamentals of thermodynamics and bioenergetics
2. Buffers, pH Scale, redox potential
3. Structure and functions of ATP;
4. Forces stabilizing macromolecules, Basic structure (all orders) and function of proteins, fats and carbohydrates

Unit – II **10 Hours**

Fundamentals of Enzymology:

5. Classification, mechanism of enzyme action and catalysis, Allosteric mechanism, active sites, isoenzymes, Coenzymes, steady state enzyme kinetics, Michaelis - Menten equation and its significance.
6. Protein – ligand binding mechanism, Hill's equation, Bisubstrate reactions,
7. Ramachandran's Plot

Unit – III **10 Hours**

Photochemistry and Photosynthesis and Carbohydrate Metabolism:

8. General concept, Photosynthetic apparatus, Photosynthetic cycle, pigments, light harvesting and non-cyclic complexes, Photo-oxidation of water, electron and proton transport, Photophosphorylation.
9. Carbon assimilation – the calvin cycle (C_3 cycle), Photorespiration and its significance, the C_4 cycle, the CAM pathway, biosynthesis of starch and sucrose, physiological and ecological considerations.

Unit – IV **10 Hours**

Respiration and fatty acid metabolism:

10. Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, oxidative phosphorylation; coupled reaction, group transfer, biological energy transducers,
11. Pentose phosphate pathway, glyoxylate cycle, alternative oxidase system;
12. Fatty acid metabolism and mechanism of regulation

Unit – V **10 Hours**

Nitrogen and sulphur metabolism:

13. Overview of biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation, nucleotide metabolism.
14. Sulphur uptake, transport and assimilation.

Secondary metabolites:

15. Elementary idea of secondary metabolities like alkaloids, lignin and phenolics (terpenes, phenols) with emphasis on flavonoids.

CH-3503 Anatomy and Reproduction in Angiosperms 50 Hours

Unit-I 10 Hours

Plant Anatomy:

1. Shoot development: organisation of shoot apical meristem (SAM), Cytological and molecular analysis, Leaf (Marginal meristem).
2. Root development: organisation of root apical meristem (RAM), Cell fates and lineage differentiation of vascular tissue, regulation of root growth.

Unit – II 10 Hours

3. Epidermal structures, ontogeny and classification of stomata, trichomes and secretory glands
4 Phloem: Structure and development of sieve elements, P-Proteins.
5. Xylem: Structure and development of tracheary elements.
6. Vascular cambium: normal and abnormal functioning.
7. Nodal Anatomy: evolution of nodal vasculature.

Unit - III 10 Hours

Embryology:

8. Formation of floral organs: floral development molecular basis of floral organ determination. Morphology of stamen, carpel and placentation, (MADS Box) Homeotic genes.
9. Megasporangium (ovule): Structure and development.
10. Female gametophyte: Megasporogensis, organisation and types of embryo sac, gene function during megagametogenesis, ultra structure of embryo sac.
11. Anther: Structure, microsporogenesis, tapetum, pollen development, including pollen wall, pollen germination and pollen tube growth, development of male gametophyte, palynology and its applications.

Unit – IV 10 Hours

12. Pollen-Pistil interactions, Pollination mechanism and vectors, double fertilization.
13. Sexual Incompatibility: its genetic basis, molecular aspects, physiology and biochemistry. Barriers to fertilization, methods to overcome incompatibility.

Unit – V 10 Hours

14. Polyembryony: causes, classification and applications.
15. Endosperm: development, types, haustoria, mosaic endosperm, ruminate endosperm, xenia, metaxenia.
16. Embryogenesis: nutrition and growth of embryo; development of dicot and monocot embryos.
17. Fruit growth and development: with special reference to legumes and cucurbits.
18. Seed anatomy
19. Apomixis and Parthenocarpy: types and importance.

CH-3504 **Plant Ecology and Phytogeography** **50 Hours**

Unit – I **10 Hours**

1. Ecological factors (light, air, water, topographic, edaphic, biotic)
2. Ecological concepts of species: Genecology and Ecological niche.
3. Population Ecology: Basic concepts, characteristics of population and population structure.
4. Community Ecology: Composition, characters, structure, origin and development of community: methods of study of structure of community.

Unit – II **10 Hours**

5. Ecological succession: Process concept and trends. Climax. (Xerosere, hydrosere)
6. Ecosystem Ecology: Structure and functions, with example of a natural and artificial ecosystem, Energy flow in ecosystem.
7. Production Ecology: Measurement methods and productivity in different ecosystems.

Unit – III **10 Hours**

8. Preliminary Knowledge of I.B.P. (International Biological Programme), M.A.B (Man and Biosphere Programme).
9. Pollution: Kinds of pollution (Air, Water, Soil and Noise) and green house gases, Ozone hole, and global warming.

Unit – IV **10 Hours**

10. Recycling of waste: Biogas, utilization and disposal of organic wastes and inorganic wastes,
11. Biodiversity and It's conservation.
12. Biogeochemical cycles of C, N, P, S, and Hydrological cycle, Nutrient sources, Nutrient budgets in terrestrial communities and aquatic communities.
13. Soil erosion and conservation, rainwater harvesting, chipko movement, van mahotsava, Afforestation, reforestation.

Unit – V **10 Hours**

Phytogeography

14. Principles of phytogeography, vegetation types and Phytogeographical regions of India. Age and area hypothesis, continental drift, endemism, Hot spots, Plant exploration. Invasion and introduction.
15. Remote sensing: Concepts, principles, processes, tools, techniques in acquisition of R.S. data. Application in ecological and meteorological research

CORE ELECTIVE COURSES

C.E.T.I- PLANT BIOTECHNOLOGY

CH-4501 A. Recombinant DNA Technology 50 Hours/4credits

Unit – I 10 Hours

1. Genetic Engineering – Definition and explanation, restriction enzymes and restriction modification system.
2. Restriction of Chimeric DNA- staggered cleavage, addition of oligopolymer tailing; blunt end ligation
3. Cloning and expression vectors – Definition and explanation: Use of propmoters and expression cassettes. Virus expression vectors; Artificial chromosomes as vector- BAC, MAC and YAC.

Unit – II 10 Hours

4. Gene sequencing: Different methods of gene isolation, Techniques for sequencing (Maxam and Gilbert method, Sanger's dideoxy method); Organo-chemical gene synthesis mechanism; c DNA synthesis using reverse transcriptase,
5. Genomics, Proteomics and Bioinformatics.

Unit – III 10 Hours

6. Isolation and purification of RNA, DNA (genomic and plasmid) and proteins; different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis; isoelectric focusing gels

Unit – IV 10 Hours

7. Protein sequencing methods, detection of post translational modifications of proteins, methods of analysis of gene expression at RNA and protein level, large scale expression such as Microarray based techniques.
8. Protein Engineering- definition and explanation, Steps involved, methods used, Achievements and future prospects.

Unit – V 10 Hours

9. RNA interference- Introduction, RNAi as tool for gene expression. RNAi as a potential therapy

Practicals/ Project 4 hours /week/2 Credits

C.E.T.I- PLANT BIOTECHNOLOGY

CH-4502 **A. Plant Tissue Culture** **50 Hours/4credits**

Unit – I **10 Hours**

1. Planning and organization of tissue culture laboratory; Basic techniques of plant tissue culture.
2. Induction and maintenance of callus and cell suspension culture.
3. Study of differentiation through organogenesis and embryogenesis.

Unit – II **10 Hours**

4. Cell line selection through suspension culture for the production of stress resistant plants, their application in crop improvement.
5. Tissue culture techniques for haploid production and their application in agriculture.
6. Meristem culture for mass and clonal propagation of ornamental plants, virus resistant plants and forests trees.

Unit – III **10 Hours**

7. In-vitro Pollination, shotgun wedding, embryo rescue technique and embryo culture.
8. Encapsulation of somatic embryos and shoot apices for artificial seeds.
9. Cryopreservation techniques for germplasm conservation.

Unit – IV **10 Hours**

10. Protoplast isolation, culture and regeneration.
11. Somatic hybridization and selection mechanism for hybrids and cybrids, with special reference to crop plants.
12. Delivery systems for gene transfer in plant through co-cultivation of explants and *Agrobacterium* or thorough direct methods-electroporation, silicon carbide method.

Unit – V **10 Hours**

13. Transgenic plants: Use of transgene for – herbicides, insecticides, virus, drought, salinity and insect resistance; male sterility and restoration systems, molecular forming.
14. Industrial application of plant tissue culture for:

i) Secondary metabolism for commercial purpose.
ii) Scale up and down stream processing for secondary metabolites

Practicals/ Project **4 hours/week/2 credits**

C.E.T.-II MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

CH-4503 **B. Microbial Biotechnology** **50 Hours/4credits**

Unit – I **10 Hours**

1. Sources and characters of industrial microbes, their isolation and methods for induction of mutations; stabilization of mutants and their isolation.
2. Fermentation technology; microbial growth, application of fermentation; batch, fed batch and their continuous cultures of microbes.
3. Patent protection for biological inventions.

Unit – II **10 Hours**

4. Bioreactors: Principles and their design.
5. Microbial transformations with special reference to steroids and alkaloids, polysaccharides.

Unit – III **10 Hours**

6. Microbiology and up gradation of alcoholic beverages.
7. Commercial production of organic acids like acetic, lactic, citric and gluconic acids.
8. Commercial production of important amino acids, insulin, steroids, vitamins and perfumes.
9. Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives.

Unit – IV **10 Hours**

10. Immobilization of microbial enzymes and whole cells and their applications in industries.
11. Use microbes in food, feed and dairy; Bioprocess engineering; Downstream processing, various steps for large-scale protein purification.
12. Single cell proteins, physiological aspects, SCP from hydrocarbons, waste materials and renewable resources, improvement in SCP production.
13. Industrial sources of enzymes; Cellulases, Xylanases, Pectinases, Amylases, Lipases, and Proteases, their production and applications.

Unit – V **10 Hours**

14. Bioconversion of waste for fuel and energy.
15. Petroleum Microbiology
16. Commercial production of biofertilizers and biopesticides.

Practicals **4 Hours /week/2 Credits**

C.E.T.-II MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

CH-4504 B. Environmental Biotechnology 50 Hours/4credits

Unit – I 10 Hours

1. Pollution and Pollutants: Cost of pollution, Kinds of Pollution and Pollutants- Air, Water, and Soil Pollution, Their effects on Plants and Ecosystems;
2. Role of Plants in Pollution Management.

Unit – II 10 Hours

3. Climate Change: Greenhouse Gases (CO_2, CH_4, N_2O, CFCs: sources and roles), Ozone layer and Ozone hole, Consequences of Climate change (acid rain, global warming, sea level rise, UV radiation).

Unit – III 10 Hours

4. Ecosystem Stability: Concept (resistance and resilience), Ecological Perturbations (natural and anthropogenic) and Their Impacts on Plants and Ecosystems, Ecology of Plant Invasion, Environmental Impact Assessment (EIA), Ecosystem Restoration.
5. Environment and energy, Energy resources – Renewable and Non-renewable. Natural resources, Loss of Diversity, causes and consequences, Environmental Auditing, Conservation of Biodiversity.

Unit – IV 10 Hours

6. Ecological Management: Concepts, Sustainable Development, Remote sensing and GIS as Tools for Resources Management.

Unit – V 10 Hours

7. Phytoremediation: Prevention and Control, Methods of reducing Environmental impacts of Chemicals, Weedicides, Pesticides and Fertilizers. Biotechnological advances in pollution control through GEMs.

Practicals/Project 4 Hours/week/2Credits

C.E.T.-III APPLIED AND STRESS PHYSIOLOGY

CH-4505 **C. Stress Physiology of Plants** **50 Hours/4credits**

Unit-I **10 Hours**

1. Biological stress vs. Physical Stress, Types of stresses and general methods of measurement of stress response (Strain),
2. Stress physiology in crop improvement
3. Response to UV stress: Injury and resistance mechanism

Unit- II **10 Hours**

4. Response to low temperature stress: Chilling, freezing, frost injury and mechanism of resistance, Adaptations
5. Response to high temperature stress: Injury and mechanism of resistance, Heat shock proteins, Adaptations

Unit –III **10 Hours**

6. Response to nutrient deficiency stress
7. Heavy metal stress, injury and mechanism of resistance, adaptations
8. Salinity stress, Ionic and salt stress injury, mechanism of resistance

Unit-IV **10 Hours**

9. Response to water deficit: Desiccation, Dehydration injury; Mechanism of resistance, Adaptations
10. Response to water excess: Flooding, hypoxia, Mechanism of resistance, Adaptations

Unit-V **10 Hours**

11. Causative agents for Biotic Stresses
12. Mechanism of Resistance against Fungal, Bacterial and viral pathogens

Practicals/Project **4 Hours/week/2Credits**

C.E.T.-III APPLIED AND STRESS PHYSIOLOGY

CH-4506 C. Applied Plant Physiology 4 hrs /week/ 4 credits 50 Hours

Unit –I 10 Hours

Crop Productivity

1. Role of crop physiology in agriculture,
2. Crop growth and productivity, phenology-crop productivity, growth factors related to biomass - concept of growth rates- canopy photosynthesis (leaf area and net assimilation rates as determining factors).
3. Light interception as a major function of leaf area-index, LAD canopy architecture- Light extinction coefficient relative growth rate. Net assimilation rate. Biomass and yield relations. Assimilate partitioning, yield and yield structure analysis.

Unit-II 10 Hours

Physiology of Crop species

4. Concept of source and sink, factors influencing source and sink size and productivity. Environmental factors determining crop growth. Light, temperature and VPD, effect of photoperiod and thermoperiod on duration of growth stages.
5. Growth and development of crop species. Juvenility, shoot growth, types of shoots, patterns of shoot growth, cambial growth and its regulation. Physiological aspects of pruning and dwarfing.
6. Growth measurements. Water relations of tree species, water uptake and transport. Concepts of transpiration rate and water use efficiency. Sexual and asexual propagation.
7. Rootstock and scion interactions.

Unit-III 10 Hours

Post-Harvest Physiology

8. Senescence and ageing in plants. Ethylene – the senescence hormone, leaf senescence. Monocarpic plant senescence. Biochemistry and molecular biology of flower senescence.
9. Gene expression during senescence.
10. Concept of physiological maturity of seeds - post harvest changes in biochemical constituents in field crops - loss of viability, loss of nutritive value, environmental factors influencing post-harvest deterioration of seeds.

Unit-IV 10 Hours

11. Physiological and biochemical changes during fruit ripening and storage. Senescence and post harvest life of cut flowers.
12. Physical, physiological and chemical control of post - harvest deterioration of fruits, vegetables and cut flowers and its significance during storage and transport.
13. Molecular approach in regulation of fruit ripening. Transgenic technology for improvement of shelf-life.

Unit-V **10 Hours**

Chemistry of Plant Produced Chemicals

1. Essential plant nutrients (major, secondary and micro), organic manures (farm yard, compost, sewage sludge, green manure, biogas slurries, etc.), production and manufacture and uses of various nitrogenous, phosphatic, potassic and complex fertilizers and fertilizer mixtures, liquid fertilizers, biofertilizers, integrated plant nutrient systems.
2. Nutrient use efficiency (principles and approaches). Soil conditioners and amendments.

Practicals/Project **4 Hours/week/2Credits**

CET-IV : MEDICINAL BOTANY

CH-4507 D. Pharmacognosy 50 Hours/ 4 hours /week/4 credits

UNIT –I 10 Hours

1. Introduction and Scope of Pharmacognosy: Pharmacognosy and modern medicine
2. Crude plant drugs

a)Sources: Geographical, Biological, Cell Culture and Sea

b)Classification: Morphological (Organized and unorganized), Taxonomical, Chemical, Pharmacological and alphabetical

3. Indigenous traditional drugs and their market adulteration of *Boerhaavia*, Shankhapuspi (*Clitoria*), Indian goose-berry, *Ocimum*, *Commiphora*, *Andrographis*.

UNIT -II

4. Types of Plant drugs and their Pharmacognostic study

a) Root drugs; *Glycyrrhiza and Ipecac, Rauvolfia, Shatavari (Asparagus), Coleus,Withania*

b) Rhizome drugs, Ginger (*Zingiber*)

c) Leaf drugs, *Andrographis, Clitoria, Senna, Artemisia*

d) Bark drugs: *Terminalia arjuna*, *Holorrhena, Taxus*

e) Flower drugs: Saffron (*Crocus*), Safflower (*Carthamus*), *Spilanthes*

f) Seed drugs: *Piper longum*, *Mucuna*

g) Fruit drugs: Cumin(*Carum cuminum*), Amla (*Emblica*), Senna pods (*Cassia senna*)

h) Whole plant drugs: *Catharanthus roseus*

UNIT -III

5. Evaluation of the drugs; Organoleptic, Microscopic, Physical, Chemical and Biological methods of evaluation
6. A brief account of various drug constituents: Carbohy+drates, Cardiac glycosides, alkaloids, volatile oils, resins quinines and steroids with particular reference to Acacia gum, amla, *Coleus*, Shatavari, *Rauvolfia*

UNIT -IV

7. Medicinal Principles and powder analysis of *Curcuma*, Cloves, Senna, Fennel and Cinnamon
8. Large scale Industrial preparation of Crude Drugs

a)Types of reactors used and extraction methods

b)Active principles and non-active principle of drugs

c)Import and Export potentials of Crude Drugs

d)Preparation of crude drugs in indigenous system of medicine

e)Quality control test – contamination, Adulteration

9. Regulatory issues in herbal drug development

C.E.P. XVD/ Practicals (Labs)/ Project 4 Hrs/ week /2 Credits

Practical Lab- (Special)

1. Histochemical analysis of the following chemical compounds:

a) Alkaloids b) Steroids c) Quinones d) Resins e) Glucosides

f) Pigments g) Volatile oils

2. Organoleptic evaluation of the following:

a) *Glycyrrhiza* (Root) b) Ginger (Rhizome) c) Eucalyptus (leaf)
d) *Terminalia arjuna* (Bark) e) *Strychnos nuxvomica* (seed) f) *Spilanthes* (Inflorescence)
3. Powder analysis. a) Curcuma b) Cloves c) Senna d) Fennel
e) Cinnamon: Market drugs: a) Turmeric b) Chillies c) Coriander
d) Wheat and Jowar
4. Qualitative and Quantitative tests for
a) Alkaloids b) Carbohydrates c) Anthraquinones d) Tannins e) Steroids f) Terpenoids
5. Growing chosen Medicinal plants in an experimental plot and preparation of Crude Drug for commercial market – Project
6. Collection of crude drugs from the market and studying their characteristics
7. Preparation of exhibits
8. Record

CET-IV : MEDICINAL BOTANY

CH-4508 D. Post-harvest technology of Medicinal Plants 50 Hours

UNIT –I 10 Hours

1. Introduction: Origin, development and evolution of Medicinal Botany
2. Importance of active principles and uses of medicinal plants in different traditional systems of medicine and Allopathy

UNIT –II 10 Hours

3. Origin, Historical background. Active principles, uses and cultivation practices of the following medicinal plants

a)*Andrographis paniculata b)Asparagus racemosus c)Bacopa monnieri d)Coleus forskohlii e)Rauwolfia serpentina f)Withania somnifera*

4. Origin, Historical background, Active principles uses and cultivation practices (including organic farming) of the following aromatic plants: a) Lemon grass (*Cymbopogon flexuosus*) b)Citronella c) Palmarosa d)*Eucalyptus citriodora*

UNIT –III 10 Hours

5. Post-harvest Management of Medicinal plants: Drying / Distillation, grading, packing and storage
6. Distillation of aromatic plants: a) Description of distillation UNIT s b) Principles of distillation c)Methods of distillation d) Maintenance and precautions for distillation UNIT s se) Yield and recovery of different aromatic plants

UNIT –IV` 10 Hours

7. Conservation of Medicinal Plants; Threatened and endangered Medicinal Plants – in-situ and ex-situ conservation
8. Preparation of Crude drugs in different systems of medicine

UNIT-V 10 Hours

9. Financial aspects of medicinal plants: a) Loans b) Subsidies
10. IPR – Patents

Reference

1. Cultivation of medicinal and aromatic crops by Farooqui and Sreeramulu..Univ. Press
2. Textbook of Pharmacognosy by Young Ken – Heber W and Young Ken
3. Pharmacognosy of indigenous drugs by K. Raghunathan and Roma Mitra
4. Pharmacognosy- Kokate et al
5. Pharmacognosy- Mohammed Ali
6. Pharmacognosy- Wallis
7. Pharmacognosy- Trease & Evans-1996
8. Pharmacognosy- Shaw and Quadri
9. Pharmacognosy- Tyler, Brady and Robbins
10. Cultivation of Medicinal plants-Purohit & Vyas CBS, 2006
11. Introduction to Medicinal Chemistry (12996). Aler Gingauz. Wiley publications.
12. Medicinal Chemistry (2001). Graham L. Patrick. Oxford University Press

C.E.P.XVI/D Practicals (Labs)/ Project **4 Hrs/ week /2 Credits**

Practical Lab- (Special)

1. Germination studies and nursery management of medicinal and aromatic plants.
2. Organoleptic and Microscopic analysis, identification and adulteration check of the following
   crude drugs.

a) Leaf drugs *Cassia sps*

b) Root drugs *Rauwolfia serpentina vs. R. tetraphylla*

c) Bark drugs *Holarrhena pubiscens vs Terminalia arjuna*

d) Flower drugs *Carthamus tinctorius*

e) Whole plant drugs *Catharanthus roseus*

3. Histochemical identification of the following chemical substances: a) Carbohydrates b)Proteins, c)Amino acids d)Starch e)Tannins f)Enzymes
4. Histological identification of tissue systems and deposits

a)Epidermis, b)Parenchyma, c)Collenchyma, d)Phloem, e)Xylem, f)Crystals etc.

5. Estimation of oil content in aromatic crops (Clemenger apparatus/SCE)

Record

CET-V : PLANT GENETIC RESOURCES AND CONSERVATION

CH-4509 E. Plant Genetic Resources and Economic Botany 50 Hours

Unit – I 10 Hours

Sustainable Development:

1. Global movement for sustainability
2. People's mandate on sustainable development
3. Strategies for sustainable development
4. Contribution of telecommunication and information technology to sustainability
5. Social perspectives for sustainable development
6. Political perspectives for sustainable development
7. Concept of circular economy

Unit – II 10 Hours

Origin of Agriculture:

8. Meaning of Agriculture, Development of Agriculture
9. Origin of cultivated plants, Indo-Burmese Centre of Origin,
10. Contribution of Vavilov,
11. Domestication of crop plants
12. Plant introduction

Unit - III 10 Hours

Green revolution:

13. Benefits and adverse consequences, beyond green revolution
14. Plants as Avenue trees: Selection of avenues and avenue trees, planting schemes
15. Plants as Pollution control agents: Tolerance of plants to different pollutants

Unit - IV 10 Hours

Origin, evolution and cytotaxonomy of

16. Cereals and millets (wheat, paddy, bajra and jowar),
17. Legumes (peas, gram, soybean, black gram, lentil and cowpea),
18. Sugarcane and starches (beetroot, potato, sweet potato,),
19. Origin of Forage and fodder crops.

Unit - V 10 Hours

20. A general account of non-wood forest products (NWFPs) such as bamboos, gum, tannins, dyes, resins and beverages.
21. A general account of the organizations and functions of Indian Council of Agricultural Research (ICAR). Council of Scientific and Industrial Research (CSIR) and the Department of Biotechnology (DBT)

Practicals/Project 4 Hours/week/2Credits

CET-V : BIODIVERSITY AND CONSERVATION

CH-4510 E. Biodiversity Conservation and Plant Resources 50 Hours

Unit - I 10 Hours

1. Biodiversity: Definition; factors responsible for determination of Biodiversity;
2. Global concern over climate change.
3. Levels of Biodiversity: Genetic, Species, Ecological, Evolutionary and Agrobiodiversity
4. Diversity Measures: (Diversity Indices)- Alpha(α), Beta (β), Gamma(γ) Diversity.

Unit - II 10 Hours

5. Biodiversity Conservation Initiatives

a) *In situ* Stratagy : National parks, Wild life sanctuaries, biosphere reserves and world heritage sites.

b) *Ex-situ* Stratagy : By seeds, reclamation, Afforestation, tree Plantation, seed banks, gene banks, cryobanks

c) General account of activities of BSI, NBPGR for conservation and non-formal conservation efforts

d) Restoration or Rehabilitation of Endangered species and degraded ecosystem

Unit - III 10 Hours

6. Biodiversity at world level: Biodiversity at global and country level, wild plant wealth.
7. Ecosystem diversity in India: Desert, forest, Grassland ecosystem, wetland, Mangroves.
8. Endemic species, cultivated plants and Agro- diversity.

Unit - IV 10 Hours

9. Loss of Biodiversity:

a) Causal factors – Developmental pressure, encroachment, exploitation, human induced and natural disaster, floods, earthquake, cyclone, landslides, Disaster management.

b) Threat to Ecosystem, species and genetic Diversity.

Categories of threats : Endangered, Vulnerable, Rare and Threatened

Unit - V 10 Hours

10. Plant resources, Concept, Status and Concern
11. Local plant diversity and its economic importance
12. World centers of primary diversity of domesticated plants
13. Biodiversity protection laws and policies, management of natural resources.

Practicals/Project 4 Hours/week/2Credits

CET-VI : APPLIED PLANT PATHOLOGY

CH-4511 F. Applied Mycology 4 hrs/week/4credits/Total 50 Hours

UNIT- I

Introduction Techniques and Information Technology

1. Introduction to Molecular Plant Pathology
2. Molecular techniques in plant pathology, RFLPs, RAPDs, polymerase chain reaction (PCR, RTPCR) - Analysis of PCR products and serological techniques based on immunofluorescence, chromosome karyotyping.
3. Fungal protoplasts and Vegetative compatibility groupings.
4. Information Technology in Plant Pathology: Plant disease clinics; use of database and application of Bioinformatics in plant pathology- a general account.

UNIT- II

Plant Pathogen Interactions

5. Recognition: Early events, Adhesion, spore eclosion, adhesion of germ tubes and hyphae factors affecting adhesion, hydrophobins.
6. Elicitiors: Distribution, production and nature, fungal wall elicitors (carbohydrates and glycoprotein elicitors) elicitors from plant cell walls, microbial enzyme elicitors, mode of action and diverse plant defense mechanisms.
7. Signal Transduction: Intracellular signals, short distance intercellular signals and systemic signals.
8. Second Messengers: Calcium ion and Calcium dependent enzymes, cyclic AMP, Proteins, H2O2 and Ethylene.
9. Systemic Signal Molecules: Oligogalacturonides, Salicylic acid, Systemin, Jasmonic acid and Lypoxygenases.

UNIT- III

Genetics of Plant Pathogen Interactions

1. Genetics of Plant Disease:
2. Basic features of sexual reproduction; Fungal nucleus; Gene organization
3. Genes and disease; Variability of organisms (Mutation, Heterokaryosis and Parasexuality).
4. Physiological Specialization, origin of races, concept of biological forms.
5. Molecular variability of fungal pathogens.

15. Genetics of virulence in pathogens: Genes involved in pathogenesis; Virulence by pathogens; brief account on plant pathogenic genes in fungi, bacteria and viruses.
16. Types of plant resistance to pathogens:

i) Non-host resistance, True resistance (Vertical and Horizontal resistance).

ii) Apparent resistance, Gene-for-gene concept, Flor's concept, Breeding resistant varieties.

UNIT- IV

Pathogen Ingress and Plant Resistance

17. Plant defense responses: Generation of signals Local and systemic responses, fungal resistance genes in plants, defense genes and fungal avirulence genes.
18. Plant lmmunizaiton: Systemically acquired resistance (SAR) Chemical inducers of plant resistance and Pathogenesis related proteins (PRPs).
19. Strategies for cloning plant resistance genes: Vector mediated transformation, Alternative

transformation methods and ldentificaiton of transformants.
20. Engineering resistance against fungal and viral pathogens: Coat protein mediated resistance (CPMR) and antisense genes and gene silencing.
21. Antifungal and antibacterial strategies: Candidate genes to combat microbial pathogens (Chitinase,Thionine, Permatins, Lysozymes and Lectins) and antifungal proteins (Ribosome inactivating proteins-RIPs).

C.E.P.XV F Practicals (Labs)/ Project 4 Hrs/ week 2 Credits

Practical Lab- (Special)

1. Isolation and separation of fungal nucleic acids and proteins by gel electrophoresis.
2. RFLPs of fungal nucleic a c id s and RAPDs of fungal DNA.
3. Amplificaiton of Fungal DNA by PCR.
4. Fungal Protoplast isolation.
5. Elaboration of phytoalexins byTLC methods.
6. Record and Herbarium of diseased plants.

Reference Books:

1) Agrios, G.N. 1999, Plant Pathology. Academic press.
2) Alexander, N. Glazer & Hiroshi Nikaido, 1995. Microbial Biotechnology, W.H. Freeman and Company.
3) Bau, A.N. & Giri, B.K. 1993. The essential of viruses, vectors and plant diseases. Wiley Eastern Limited.
4) Bernard R. Glick & Jack J. Pasternak. 1996, Molecular Biotechnology, Panima Publishing Company.
5) Bridge, P., Jeffriens, P. and Morse, D.R., 1998, Information technology, plant Pathology and Biodiversity, CAB international Publications.
6) Bridge, P.D. 1995, Molecular Variability of Fungal Pathogens, CABI Publ.
7) Bridge, P.D., Arora, D.K., Reddy, C.A. & Elander, R.P. 1998. Applications of PCR in Mycology,
8) Callow, J.A. 1983. John Wiley & Sons, Biochemical Plant pathology.
9) Chandanwala, K. 1986 Introduction of Plant pathology Anmol Publications Pvt. Ltd. New Delhi.
10) Dubey, R.C. 1995. A Text Book of Biotechnology, S. Chand & Company Ltd.
11) Greg J. Boland & Kuykendall, L.D. 1998. Plant Microbe Interactions and Biological Control. Marcel
Dekker Inc.
12) Gurr, S.J. & Mc. Pherson, M.J. & Bowles, D.J. 1992. Molecular Plant Pathology, Vol. I & II Oxford
13) Horst w. Doelle, 1994, Microbia Process Development, World Scientific
14) Marshall, G. & Walters, D. 1994 Molecular Biology in Crop Protection, Chapman & Hall.
15) Mehrotra, R.S. 1991 Plant pathology, Tata Megrew – Hill Publishing Comp Ltd.
16) Natish, S. Chopra, V.L. & Ramachandran, S. 1994. Biotechnology in Agriculture Oxford and IBH
Publishing Company.
17) Natish, S., Chopra, V.L. & Ramachandran, S. 1994 Biotechnology Agriculture Oxford and IBH Publishing Company.

CET VI: APPLIED PLANT PATHOLOGY

CH-4512 F. Molecular Plant Pathology 4hrs/week/4 Credits/ Total 50 hrs

UNIT- I

1. Introduction and History of Plant Pathology
2. Classification of plant diseases: Symptomology of Fungal, Bacterial, Viral and Phytoplasmal diseases
3. Plant diseases caused by Phanerogamic plant parasites- *Loranthus, Orobanche, Striga and Cuscuta.*
4. Nematode disease - Root knot of tomato caused by *Meloidogyne*
5. General account of post-harvest fungal diseases of food crops, fruits and vegetables and their management.

UNIT- II

Plant diseases caused by Bacteria, Viruses, Viroids, Phytoplasma and Spiroplasmas

6. Plant diseases caused by Bacteria:

a) Wildfire of Tobacco; b) Angular leaf spot of Cotton; c) Leaf spot of Mango; d) Wilt of Potato e) Wilt of Tomato; f) Soft rot and Scab of Potato;

7. Plant diseases caused by Viruses & Viroids:

a) Bhindi vein clearing; b) Papaya leaf curl; c) Bunchy top of Banana; d) Rice Tungro e) Bud necrosis of Groundnut; f) Bean common mosaic; g) Potato spindle tuber

8. Plant diseases caused by Phytoplasmas and Spiroplasmas:

a) Grassy shoot of Sugarcane c) Sandalwood spike; b) Little leaf of Brinjal d) *Sesamum* phyllody

UNIT- III

Fungal Diseases of Cereals, Plantation crops, Pulses and Oil Seeds

9. Cereals:

a) Bakanae disease of Rice; b) Sheath blight disease of Rice; c) Loose smut of Wheat; d) Karnal bunt of Wheat; e) Grain smut of Sorghum; f) Loose smut of Sorghum; g) Downy mildew of Bajra h) Common smut of Maize

10. Plantation crops:

a. Coffee Rust; b. Blister blight of Tea; c. Stem rot of Rubber

11. Pulses and Oil Seeds:

a) Pigeon pea Wilt **b)** Chick pea Blight; **c)** Rust of Groundnut; **d)** Sunflower Rust; **e)** Linseed Rust **f)** Coconut Bud rot

UNIT- IV

Fungal Diseases of Fruits, Vegetables and Cash crops

12. Fruits:

a) Downy mildew of Grapes; b) Powdery mildew of grapes; c) Mango Anthracnose; d) Citrus Gummosis

13. Vegetables:

a) Powdery mildew of Cucurbits; b) Leaf spot of Tomato; c) Leaf spot of Brinjal; d) Club root of Crucifers; e) Chilli Die-back

14. Cash crops:

a) Whip smut of Sugarcane; b) Cotton Wilt; c) Damping off of Tobacco; d) Black Shank of Tobacco e) Turmeric Leaf spot

C.E.P.XVI F Practicals (Labs)/ Project 4 Hrs/ week 2 Credits

Practical Lab- (Special)

1. Diagnosis of plant diseases and proof of pathogenicity according to Koch's postulates.
2. Measurement of plant diseases- Disease scoring.
3. Plant disease diagnosis by studying symptoms in the field.
4. Preparation of semi-permanent slides of diseased material, eg. Leaf spots, blights, mildews, rots, wilts, rusts and smuts.
5. Micrometry and standardization of microscope.
6. Measurement of fungal spores and mycelium and camera Iucida drawings
7. Record and Herbarium of diseased plants.

CET-VII : COMPUTER SCIENCE , BIOINFORMATICS & GENOMICS

CH-4513 G.Elementary Knowledge of Computers and Bioinformatics 4 hrs/week/4 Credits/ Total 50 Hours

Unit –I **10 Hours**

1. Computer System- Definition; Components (Input/Output unit, Control Unit., Primary Storage Unit, Arithmetic and Logic Unit); Types of Memory, Generation of Computers
2. Number System & Logic Gates- Application of Number Systems (Decimal Number System, Binary Number System, Hexadecimal Number System) & Conversions (Decimal to Binary, Binary to Decimal, Decimal to Hexadecimal, Hexadecimal to Binary); Addition operation in Binary Number System; Introduction to Logic Gates(AND, OR, NOT, NAND, NOR, XOR XNOR); Introduction to Software.

Unit- II **10 Hours**

3. Bioinformatics - Introduction; Definition & Concept, Role of Bioinformatics, Introduction of Internet in Biology & objectivity, Services of Internet used for Biological Data, Human Genome Project.

Unit- III **10 Hours**

4. Database System- Definition; Purpose of Database System; Advantages of Database System, Relational Database- Definition; Relational Data Model, Database- Primary Databases & Secondary Databases, Sequence Databases(EMBL, GenBank, DDBJ, SWISS-PROT, PIR, TrEMBL), Protein Family/Domain Databases (PROSITE, Pfam, PRINTS & SMART)

Unit- IV **10 Hours**

5. Sequence comparison algorithm, Dynamic programming, Dot plot matrix, sequence scoring schemes (weight matrix as Identify scoring, genetic code scoring scheme chemical scoring, observed Substitution matrix and Gap penalties),Sequence database similarity searching algorithms, local alignment, global alignment, FAST A, BLAST (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX) and similarity searching scores and their statistical interpretation

Unit-V **10 Hours**

6. Motifs and Domains, algorithm for multiple alignments, Biological motifs, micro array, Phylogenetic prediction: Relationship of Phylogenetic analysis to sequence alignment, Genome complexity and phylogenetic analysis, concept of evolutionary trees. Maximum parsimony method, distance method, maximum likelihood method

Practicals/Project **4 Hours/week/2Credits**

CET-VII : COMPUTER SCIENCE , BIOINFORMATICS & GENOMICS

CH-4514 G. Genomics in Plant Improvement 4 hrs/week/4 Credits/Total 50 Hours

Unit-I 10 Hours

Introductory plant genomics: Overview of genomic assisted breeding and functional genomics, role in plant/crop improvement, Different molecular marker types: RFLP, RAPD, AFLP, SSRs; STSs; SNP, EST-SSR, EST-SNPs etc, markers from functional portion of genome (etc.), high-throughput genomics. Model plant genomes: *Arabidopsis, Brachypodium* and rice, plant genome databases.

Unit-II 10 Hours

High-throughput genotyping: Different high-throughput genotyping platforms (Radseq, chip based, etc), comparative genomics (collinearity/synteny in maps), genome duplication.

Genome and base editing technologies: Genome-editing using programmable nucleases (ZFNs, TALENs) genome editing using CRISPR/CAS, base editing etc. Role in crop plant improvement.

Unit-III 10 Hours

Whole genome sequencing : Whole genome shotgun sequencing; clone-by-clone or 'hierarchical shotgun' sequencing; different next generation sequencing (NGS) technologies (454, Illumina, ABI SOliD, single molecule and nanopore sequencing); deep sequencing and re-sequencing of genomes; application of NGS in functional genomics, allele mining for crop improvement.

Unit-IV 10 Hours

Forward and reverse genetic tools in genomics: Positional cloning (genetic mapping, physical maps, EST/transcript maps, functional maps); Insertional mutagenesis (activation tagging); enhancer/promoter trap; whole genome LD mapping, map-based cloning and fine mapping of genes; candidate gene approach, insertion mutagenesis (T-DNA and transport insertion), VIGs, RNAi, TILLING, Eco-TILLING

Unit-V 10 Hours

Transgenic plants: Transgenic trait development, trait integration-backcrossing transgenes, molecular characterization, gene/trait stacking, development, utility and commercialization of transgenic crop (resistance for biotic and abiotic stresses; barnase and barstar for hybrid seed production, engineering for vitamins and nutritional mineral deficiency); molecular farming for production of foreign proteins and edible vaccines; biosaftey issues; biosafety regulations.

Practicals/Project 4 Hours/week/2Credits

OPEN ELECTIVES (Offered by the department for the students of other departments)

CO-6610 OET –I: DISASTER MANAGEMENT 4 hrs/ week/ 4 Credits/ 50 hrs

UNIT- I 10 Hrs

Introduction to Disasters: Concepts, and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks.

UNIT- II 10 Hrs

Disasters: Classification, natural hazards and Man-made disasters, Causes, Impacts (including social, economic, political, environmental, health, psychosocial, etc.) Global trends in disasters, urban disasters and climatic change.

UNIT- III 10 Hrs

Approaches to Disaster Risk reduction: Disaster management cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Role of NDMA, NDRF, NIDM, STATE DM in disaster Management.

UNIT - IV 10 Hrs

Disasters and Development: Impact of Development projects such as dams, embankments, changes in Land-use etc, Climate Change. Relevance of indigenous knowledge and local resources

UNIT - V 10 Hrs

Disaster Risk Management in India: Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy).

Suggested Reading list:

Alexander David, Introduction in 'Confronting Catastrophe', Oxford University Press, 2000

Andharia J. Vulnerability in Disaster Discourse, JTCDM, Tata Institute of Social Sciences Working Paper no. 8, 2008

Blaikie, P, Cannon T, Davis I, Wisner B 1997. At Risk Natural Hazards, Peoples' Vulnerability and Disasters, Routledge.

Coppola P Damon, 2007. Introduction to International Disaster Management,

Carter, Nick 1991. Disaster Management: A Disaster Manager's Handbook. Asian Development Bank, Manila Philippines.

Cuny, F. 1983. Development and Disasters, Oxford University Press.

Document on World Summit on Sustainable Development 2002.

Govt. of India: Disaster Management Act 2005, Government of India, New Delhi.

Government of India, 2009. National Disaster Management Policy,

Gupta Anil K, Sreeja S. Nair. 2011 Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi

Indian Journal of Social Work 2002. Special Issue on Psychosocial Aspects of Disasters, Volume 63, Issue 2, April.

Kapur, Anu & others, 2005: Disasters in India Studies of grim reality, Rawat Publishers, Jaipur
Kapur Anu 2010: Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi.
Parasuraman S, Acharya Niru 2000. Analysing forms of vulnerability in a disaster, The Indian Journal of Social Work, vol 61, issue 4, October

OPEN ELECTIVES (Offered by Botany department for the students of other departments)

CO-7610 OET –II: ENVIRONMENTAL AWARENESS 4 hrs/ week/ 4 Credits/ 50 hrs

UNIT- I 10 Hours

1. Multidisciplinary nature of environmental studies, Definition, scope and importance, Need for public awareness.

UNIT- II 10 Hours

2. Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources.

UNIT- III **10 Hours**

3. Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers. 4. Energy flow in the ecosystem. 5. Ecological succession. 6. Food chains, food webs and ecological pyramids. 7. Introduction, types, characteristic features, structure and function of the following ecosystem:- a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT- IV **10 Hours**

8. Social Issues and the Environment 9. From Unsustainable to Sustainable development 10. Urban problems related to energy 11. Water conservation, rain water harvesting, watershed management 12. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. 13. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Public awareness**.**

UNIT- V **10 Hours**

14. Human Population and the Environment, Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies.

Open Electives offered by Campus Departments for 2016-17

History:
1. Indian rituals and Karma
2. Indian Culture and heritage

Urdu:
1. Mass Media
2. Urdu Proficiency

Psychology:
1. Personality Development and Communication Skills
2. Psychology and Spirituality

Chemistry:
1. Chemistry of Life-I
2. Chemistry of Life-II

Mathematics:
1. Optimization techniques
2. Basic cryptography

Zoology:
1. Poultry Science and Dairy Management
2. Wild life and Forestry

Toxiciology:
1. Chemical disaster Management
2. Forensic toxicology

Statistics:
1. Applied Statistics
2. Essential Statistics

Physics:
1. Introduction to Nanotechnology
2. Electron Microscopy

Botany:
1. Disaster Management
2. Environmental Awareness

Microbiology:
1. Food Safety and Quality Control

2. Public Health and Hygiene

English:
1. Human Society
2. Personality development and Communication skills

Hindi:
1. Functional Hindi
2. Hindi journalism

Economics:
1. Basic economics
2. Developments in Indian Economics

Genetics and Plant Breeding:
1. Crop Physiology
2. Crop Biochemistry

Sociology:
1. Rural Development: concepts and Dimensions
2. Social Change in India

Political Science:
1. Human rights
2. Constitution of India