### 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

<table>
<thead>
<tr>
<th>I Semester</th>
<th>Course Title</th>
<th>Credits</th>
<th>Total Marks (Int.+Ext.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Compulsory Theory I/CH-1501</td>
<td>Phytotechniques and Biostatistics</td>
<td>4</td>
<td>40+40</td>
</tr>
<tr>
<td>C.C.T II/CH-1502</td>
<td>Microbiology</td>
<td>4</td>
<td>40+40</td>
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<tr>
<td>C.C.T III/CH-1503</td>
<td>Algae and Bryophytes</td>
<td>4</td>
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<tr>
<td>C.C.T IV/CH-1504</td>
<td>Taxonomy of Angiosperm and Economic Botany</td>
<td>4</td>
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<tr>
<td>C.C. Practical -I (4 Hours) CH-501</td>
<td>Based on Courses I-IV</td>
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<tr>
<td>Open Elective I: CO-56 - - - -</td>
<td>Self- Study-1A. Hindi/ B. English/C. Urdu/D. Sanskrit</td>
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<td><strong>Total Credits/marks</strong></td>
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<thead>
<tr>
<th>II Semester</th>
<th>Course Title</th>
<th>Credits</th>
<th>Total Marks (Int.+Ext.)</th>
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<tbody>
<tr>
<td>C.C.T V/CH-2501</td>
<td>Mycology and Plant Pathology</td>
<td>4</td>
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<tr>
<td>C.C.T VI/CH-2502</td>
<td>Pteridophytes, Gymnosperms and Palaeobotany</td>
<td>4</td>
<td>40+40</td>
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<tr>
<td>C.C.T VII/CH-2503</td>
<td>Molecular Biology and Biotechnology</td>
<td>4</td>
<td>40+40</td>
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<tr>
<td>C.C.T VIII/CH-2504</td>
<td>Cell Biology &amp; Genetics</td>
<td>4</td>
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<tr>
<td>C.C.P II (4 Hours) CH-601</td>
<td>Based on Courses V-VIII</td>
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<tr>
<td>Open Elective II CO-6610</td>
<td>Disaster Management</td>
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<table>
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<th>III Semester</th>
<th>Course Title</th>
<th>Credits</th>
<th>Total Marks (Int.+Ext.)</th>
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<tr>
<td>C.C.T IX/CH-3501</td>
<td>Plant Water relations; Growth and Development</td>
<td>4</td>
<td>40+40</td>
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<tr>
<td>C.C.T X/CH-3502</td>
<td>Phytochemistry and Metabolism</td>
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<td>C.C.T XI/CH-3503</td>
<td>Anatomy and Reproduction in Angiosperms</td>
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<td>C.C.T XII/CH-3504</td>
<td>Plant Ecology and Phytogeography</td>
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<td>C.C P III (4 Hours) CH-701</td>
<td>Based on theory courses IX-XII</td>
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<td>Open Elective III: CO-7610</td>
<td>Environmental Awareness</td>
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<tr>
<td>Specializations</td>
<td>IV Semester</td>
<td>Course Title (Core Elective Courses (Any Set of two courses each, for 2 specializations) CET-I to CET-VII)</td>
<td>Credits</td>
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<tr>
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<tr>
<td>C.E.T-I Plant Biotechnology</td>
<td>Course XIII / CH-4501</td>
<td>A. Recombinant DNA technology</td>
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<tr>
<td></td>
<td>Course XIV / CH-4502</td>
<td>A. Plant Tissue Culture</td>
<td>4</td>
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<td>C.E.T. II. Microbial and Environmental Biotechnology</td>
<td>Course XV / CH-4503</td>
<td>B. Microbial Biotechnology</td>
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<tr>
<td></td>
<td>Course XVI / CH-4504</td>
<td>B. Environmental Biotechnology</td>
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<td>C.E.T.III. Applied and Stress Physiology</td>
<td>Course XIII / CH-4505</td>
<td>C. Stress Physiology of Plants</td>
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<td>Course XIV / CH-4506</td>
<td>C. Applied Plant Physiology</td>
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<td>C.E.T.IV Medicinal Botany</td>
<td>Course XV / CH-4507</td>
<td>D. Pharmacognosy</td>
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<tr>
<td></td>
<td>Course XVI / CH-4508</td>
<td>D. Post-Harvest technology of medicinal plants</td>
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<tr>
<td>C.E. V Plant Genetic Resources and Conservation</td>
<td>Course XV/CH-4509</td>
<td>E. Plant Genetic Resources and economic Botany</td>
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<td>Course XVI/CH-4510</td>
<td>E. Biodiversity conservation and Plant Resources</td>
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<tr>
<td>C.E. VI. Applied Plant Pathology</td>
<td>Course XV/CH-4511</td>
<td>F. Applied Mycology</td>
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<td>Course XVI/CH-4512</td>
<td>F. Molecular Plant Pathology</td>
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<tr>
<td>C.E. VII Computer Science, Genomics &amp; Bioinformatics</td>
<td>Course XIII/CH-4513</td>
<td>G. Elementary Computer knowledge and Bioinformatics</td>
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<td>Course XIV/CH-4514</td>
<td>G. Genomics for Plant improvement</td>
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<tr>
<td>C.C.P. IV (4 hours)</td>
<td>Practical/Project</td>
<td>Based on theory courses XIII-XIV, XV-XVI</td>
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<td>based on two sets of Core Electives / CH-801</td>
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<td>Open Elective 4:</td>
<td>Self-Study 4 CO-8610</td>
<td>Intellectual Property Rights/Project/ Courses provided by other departments</td>
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<tr>
<td></td>
<td>Grand Total Credits/marks</td>
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</table>

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.
Unit I 

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 

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

Unit III 

Methods of quantitative analysis-
6. Spectrophotometry, MS, NMR, ESR, ORD/CD spectrometers,
8. Immunological methods: immunodiffusion, immuno-electrophoresis, crossed immuno-electrophoresis, counter- RIA, ELISA, Immunoblotting

Unit IV 

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.
12. Principle of experimental designs, randomized block and Latin square designs and Analysis of Variance (ANOVA).
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

Bacteria:
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

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

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

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.
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 Hydrodictyon, Pithophora, Ulva, Cosmarion, 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.

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 – IV
10 Hours
15. Evolutionary tendencies in sporophytes of Bryophytes (Progressive sterilization of
    sporogenous tissue)
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.
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

   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- IV  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
6. Differentiation in fungi: control of i) Dimorphism. ii) conidiation. iii) mating (with the help of Sex hormones).

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, Phytophthora, Albugo,
III. The Kingdom Fungi:
   a. Chytridiomycota: Synchytrium,
   b. Blastocladiomycota: Allomyces, Coelomomyces
   c. Zygomycota: Saksanacea, 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
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
16. 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.
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 (Isoetes).
   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

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.

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.
11. Cycadales: A detailed account including distribution of living Cycads.
17. Ephedrales, Welwitschiales and Gnetales: A general account.

Unit – III

18. Evolutionary tendencies in Gymnosperms.
Unit – V

Paleobotany:
  20. Geological areas and distribution of plants in geological time scale.
  22. Techniques of study of fossils.
  23. Distribution of fossils in India
Unit – I

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

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.

Unit – III

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

Unit – IV

10. PCR: Principles, techniques and modification, Gene cloning vs PCR; Uses and applications of PCR.

Unit – V

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,
1. The Dynamic cell: Structural organization of plant cell, specialized plant cell.
3. Plant Cell inclusions, their structure and function; Mitochondria, Chloroplast, Ribosome, Dictyosomes, Lysosomes, ER, Microbodies and Plasmodesmata.

Unit – II

5. Chromatin Organisation: Chromosome structure and composition, Centromere, Telomere, Euchromatin and Heterochromatin, Karyotypes, Polytene, Lamp brush chromosomes and Sex chromosomes.
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

9. Allelic and non-allelic interaction of genes.
10. Multiple alleles: alleles, coat colour in rodents, blood groups in Humans, self-incompatibility

Unit – IV

11. Linkage and crossing over: chromosome mapping, linkage groups, mechanism of chromosome pairing and synaptonemal complex.
12. Sex determination in plants.
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

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.
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.

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,

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

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.

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:
9. Carbon assimilation – the calvin cycle (C3 cycle), Photorespiration and its significance, the C4 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.
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).

Unit – II  10 Hours
3. Epidermal structures, ontogeny and classification of stomata, trichomes and secretory glands
5. Xylem: Structure and development of tracheary elements.

Unit - III  10 Hours

Embryology:
10. Female gametophyte: Megasporogenesis, 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
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.
Unit – I 10 Hours

1. Ecological factors (light, air, water, topographic, edaphic, biotic)
2. Ecological concepts of species: Genecology and Ecological niche.

Unit – II 10 Hours

5. Ecological succession: Process concept and trends. Climax. (Xerosere, hydrosere)
7. Production Ecology: Measurement methods and productivity in different ecosystems.

Unit – III 10 Hours

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.

Unit – V 10 Hours

Phytogeography
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 promoters 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.

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/4 credits

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.

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
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/4 credits

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.

Unit – II 10 Hours
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.

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
15. Petroleum Microbiology

Practicals 4 Hours/week/2 Credits
C.E.T.-II MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

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

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 (CO₂, CH₄, N₂O, 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.

Unit – IV 10 Hours


Unit – V 10 Hours


Practicals/Project 4 Hours/week/2 Credits
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

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,

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.
7. Rootstock and scion interactions.

Unit-III 10 Hours

Post-Harvest Physiology
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.
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.


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, Rauwolfia, 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: Carbohydrates, Cardiac glycosides, alkaloids, volatile oils, resins quinines and steroids with particular reference to Acacia gum, amla, Coleus, Shatavari, Rauwolfia

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 e) 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
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
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 pubescens* 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),  

#### 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
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. Elicitors: 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.

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.
transformation methods and identification 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 acids and RAPDs of fungal DNA.
3. Amplification of Fungal DNA by PCR.
5. Elaboration of phytoalexins by TLC methods.
6. Record and Herbarium of diseased plants.

Reference Books:
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
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.
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 lucida drawings
7. Record and Herbarium of diseased plants.
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; biosafety 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

Suggested Reading list:
Coppola P Damon, 2007. Introduction to International Disaster Management,
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
Kapur, Anu & others, 2005: Disasters in India Studies of grim reality, Rawat Publishers, Jaipur

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

UNIT - IV 10 Hours

UNIT - V 10 Hours
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

Toxicology:
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