Syllabus

B.Sc. BOTANY (Hons)
w.e.f. the Academic Year 2016-2017

Choice Based Credit System (CBCS)

BERHAMPUR UNIVERSITY
BHANJA BIHAR, BERHAMPUR-760007
ODISHA

Choice Based Credit System (CBCS)
Syllabus for B.Sc. BOTANY (Hons), Berhampur University w.e.f. the Academic Year 2016-2017
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Semester – I		**Credits**
Core-I	Microbiology and Phycology (Theory)	4
Practical/Lab work	Practical/Lab work (Core-I)	2
Core-II	Biomolecules and Cell Biology (Theory)	4
Practical/Lab work	Practical/Lab work (Core-II)	2
GE-I (Generic Elective)	<From other subject>	4
GE-I (Practical/Lab work)	<From other subject> (Practical/Lab work)	2
AECC-I(Ability Enhancement Compulsory Course)	Environmental Studies (Theory)	2
Semester – II		
Core-III	Mycology and Phytopathology (Theory)	4
Practical/Lab work	Practical/Lab work (Core III)	2
Core-IV	Archegoniate (Theory)	4
Practical/Lab work	Practical/Lab work (Core IV)	2
GE-II(Generic Elective)	<From other subject>	4
GE-II (Practical/Lab work)	<From other subject> (Practical/Lab work)	2
AECC-II(Ability Enhancement Compulsory Course)	MIL Communication	2
Semester – III		
Core-V	Anatomy of Angiosperms (Theory)	4
Practical/Lab work	Practical/Lab work (Core V)	2
Core-VI	Economic Botany (Theory)	4
Practical/Lab work	Practical/Lab work (Core VI)	2
Core-VII	Genetics (Theory)	4
Practical/Lab work	Practical/Lab work (Core VII)	2
GE-III(Generic Elective)	<From other subject>	4
GE-III (Practical/Lab work)	<From other subject> (Practical/Lab work)	2
SEC-I(Skill Enhancement Course)	Communicative English	2
Semester – IV		
Core-VIII	Molecular Biology (Theory)	4
Practical/Lab work	Practical/Lab work (Core VIII)	2
Core-IX	Plant Ecology and Phytogeography (Theory)	4
Practical/Lab work	Practical/Lab work (Core IX)	2
Core-X	Plant Systematics (Theory)	4
Practical/Lab work	Practical/Lab work (Core X)	2
GE-IV(Generic Elective)	<From other subject>	4
GE-IV(Generic Elective)	<From other subject> Practical/Lab work	2

SEC-II(Skill Enhancement Course)	<From the pool of SEC courses>	2
Semester – V		
Core-XI	Reproductive Biology of Angiosperms (Theory)	4
Practical/Lab work	Practical/Lab work (Core XI)	2
Core-XII	Plant Physiology (Theory)	4
Practical/Lab work	Practical/Lab work (CoreXII)	2
DSE-I (Discipline Specific Elective)	Stress Biology (Theory)	4
Practical/Lab work	Practical/Lab work (DSE-I)	2
DSE-II (Discipline Specific Elective)	Plant Breeding (Theory)	4
Practical/Lab work	Practical/Lab work (DSE -II)	2
Semester – VI		
Core-XIII	Plant Metabolism (Theory)	4
Practical/Lab work	Practical/Lab work (Core XIII)	2
Core-XIV	Plant Biotechnology (Theory)	4
Practical/Lab work	Practical/Lab work (Core XIV)	2
DSE-III(Discipline Specific Elective)	Natural Resource Management (Theory)	4
Practical/Lab work	Practical/Lab work (DSE-III)	2
DSE-IV(Discipline Specific Elective)	Biostatistics (Theory)	4
Practical/Lab work	Practical/Lab work (DSE-IV)	2
	Total	**140**

Note: There is no midterm Exam for the practical/Lab papers

Two Generic Elective Courses (GE) meant for Honours Students of other Disciplines (Each course is of 4+2= 6 credits)

I. Biodiversity (Microbes, algae , Fungi and Archegoniate)
II. Economic Botany and Plant Biotechnology

Skill Enhancement Courses (SEC)

I. Biofertilsers
II. Ethnobotany
III. Mushroom Culture Technology

SEMESTER-I

Core Courses I

Microbiology and Phycology (Theory)

UNIT-I	Introduction to microbial world, microbial nutrition, growth and metabolism. **Viruses:** Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses. **Bacteria:** Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination. Economic importance of bacteria
UNIT-II	**Algae:** General characteristics: distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food, flagella; and methods of reproduction; classification of algae given by Fritsch, significant contributions of important phycologists (F.E. Fritsch and M.O.P. Iyengar). Economic importance of algae. **Cyanophyta:** General characteristics: distribution, cell structure, ultrastucture, heterocyst, reproduction; Morphology and life-cycle of *Oscillatoria* and *Nostoc;* Economic importance of Cyanophyta.
UNIT-III	**Rhodophyta:** General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Polysiphonia*. **Phaeophyta:** Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Fucus.*
UNIT-IV	**Xanthophyta:** General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of *Vaucheria.* **Chlorophyta:** General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles, *Volvox, Oedogonium, Coleochaete.* **Charophyta:** General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*; evolutionary significance.

Practical/ Lab work (Core course I)

- Types of Bacteria to be observed from temporary/permanent slides/photographs- (bacteria, binary fission, endospore, conjugation, root Nodule)
- Gram staining
- Endospore staining with malachite green using the (endospores taken from soil bacteria)
- Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Fucus and Polysiphonia,* temporary preparations and permanent slides.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B.

(2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi

Core Course II
Biomolecules and Cell Biology (Theory)

UNIT-I	**Biomolecules:** Types and significance of chemical bonds; Structure and properties of water; pH and buffers. **Carbohydrates:** Nomenclature and classification; monosaccharide, Disaccharides Oligosaccharides and polysaccharides. **Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. **Proteins:** Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; Isoelectric point; Protein denaturation and biological roles of proteins. **Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA;Types of RNA; Structure of tRNA.
UNIT-II	**Bioenergenetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions.ATP: structure and its role as a energy currency molecule **Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.
UNIT-III	**The cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). **Cell wall and plasma membrane:** Chemistry, structure and function of cell wall. Overview of membrane structure and function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. **Cell organelles:** Chloroplast, mitochondria and peroxisomes**:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Vacuoles
UNIT-IV	**Nucleus;** Structure-nuclear envelope, nuclear porecomplex, nuclear lamina, molecular organization of chromatin; nucleolus. **Cytoskeleton:** Role and structure of microtubules, microfilaments and intermediary filament **Cell division:** Eukaryotic cell cycle and regulation, different stages of mitosis and meiosis

Practical/ Lab work (Core course II)

- Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars and proteins.
- Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum*.
- Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
- Measurement of cell size by the technique of micrometry.

- Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
- Study the phenomenon of plasmolysis and deplasmolysis.
- Study different stages of mitosis and meiosis using acetocarmine and acetoorcine method.

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A.8th edition.
8. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition.Pearson Benjamin Cummings Publishing, San Francisco

SEMESTER-II

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Core Course III

Mycology and Phytopathology (Theory)

UNIT-I	Introduction to true fungi **Fungi:** General characteristics: affinities with plants and animals; thallus organization; cell wall composition; nutrition; classification, Economic importance of fungi **Chytridiomycota and Zygomycota:** characteristic features; ecology and significance; thallus organisation; reproduction; life cyclewith reference to *Synchytrium, Rhizopus* .
UNIT-II	**Ascomycota:** General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces, Aspergillus*, *Alternaria* and *Neurospora* **Basidiomycota:** General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence and Mushroom Cultivation.
UNIT-III	**Oomycota:** General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.* **Symbiotic associations:** Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.
UNIT-IV	**Phytopathology:**Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

Practical/ Lab work (Core course III)
• *Rhizopus, Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts and sexual structures through permanent slides/photographs • *Alternaria:* Specimens/photographs and temporary mounts. • *Puccinia*: specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts. • *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown. • *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides. • Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through

permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs) • Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

Suggested Readings

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers, India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India

Core Course IV
Archegoniate (Theory)

UNIT-I	**Introduction:** Silent features of archegoniate; Transition to land habit; Alternation of generations. **Bryophytes:** General characteristics; Adaptations to land habit; Classification; Range of thallus organization.
UNIT-II	**Type Studies- Bryophytes** Classification (up to family), morphology, anatomy and reproduction of *Riccia, Marchantia, Porella, Anthoceros and Sphagnum*; Reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros* and *Sphagnum* (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.
UNIT-III	**Pteridophytes :G**eneral characteristics; Classification (up to family), morphology, anatomy and reproduction of Early land plants (*Rhynia*), *Psilotum, Selaginella, Equisetum* and *Pteris* (Developmental details not to be included).Apogamy, and apospory, heterospory andseed habit, telome theory, stelar evolution; Ecological and economic importance.
UNIT-IV	**Gymnosperms:** General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance.

Practical/ Lab work (Core course IV)
• ***Marchantia***- (all temporary and permanent slides); ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores,pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide)***. Pellia, Porella***- Permanent slides, ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only). • ***Funaria***: study of gametophyte and sporophorophyte (permanent slide

- ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide).
- ***Selaginella***: permanent slide
- ***Equisetum***- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
- ***Pteris***- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
- ***Cycas***- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
- ***Pinus***- Morphology, transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, longitudinal section of female cone, tangential longitudinal section &radial longitudinal sections stem (permanent slide).
- ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers,New Delhi, India.
2. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot.Allahabad.
3. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
4. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

SEMESTER-III

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Core Course V

Anatomy of Angiosperms (Theory)

UNIT-I	Introduction and scope of Plant Anatomy; Applications in systematics, forensics and pharmacognosy. Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.
UNIT-II	Apical meristems: Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory).
UNIT-III	Vascular Cambium and Wood: Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.
UNIT-IV	Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and non-glandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

Practical/Lab work (Core course V)

- Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples
- Apical meristem of root, shoot and vascular cambium, distribution and types of parenchyma, collenchyma and sclerenchyma
- Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres; Wood: ring porous; diffuse porous; tyloses; heart- and sapwood
- Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres
- Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
- Root: monocot, dicot, secondary growth of Stem: monocot, dicot - primary and secondary growth; periderm; lenticels
- Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy)
- Adaptive Anatomy: xerophytes, hydrophytes; Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings

- Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
- Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.

- Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
- Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

Core Course VI
Economic Botany (Theory)

UNIT-I	**Origin of Cultivated Plants:** Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.
UNIT-II	**Cereals and Legumes:** Nutritional values of cerials, millets and pulses**,** Wheat and Rice, millets (*Pannicetum, Sorghum Eleusine*), legumes (Chick pea, Pigeon pea and fodders, their origin, cultivation and processing, Importance to man and ecosystem. **Sources of sugars and starches:** Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.
UNIT-III	**Spices:** Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper **Sources of oils and fats:** General description, uses and health implications of groundnut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.
UNIT-IV	**Drug-yielding plants:** Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards). **Biofuel plants:** Bioethanol (maiz and sugarcane) Biodiesel (*Jatropha carcus*) cultivation and and processing, **Natural Rubber:** Para-rubber: tapping, processing and uses. **Timber plants:** General account with special reference to teak and pine. **Fibers:** Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Practical/Lab work Core course VI)

- Collection, identification and preparation of list of locally available plants/plant products (specimen/ photographs) with proper description:-Cereals, Legumes, Spices, Beverages, oil yielding plants, Drug-yielding plants, Woods, Fiber-yielding plants

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett opublishers

Core Course VII
Genetics (Theory)

UNIT-I	**Mendelian genetics and its extension:** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant trait; extra chromosomal inheritance, epigentics, autosomes and sex chromosomes; chromosome morphology and karyotype.
UNIT-II	**Linkage, crossing over and chromosome mapping:** Linkage and crossing over, Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Gene mapping; Sex Linkage.
UNIT-III	**Variation in chromosome structure and number:** Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy, induction of polyploidy **Gene mutations:** Types of mutations: spontaneous and induced, Molecular basis of mutations; Mutagens – physical and chemical agents (Base analogs, deaminating, alkylating and intercalating agents); Transposons. DNA damage and repair,
UNIT-IV	**Gene and gene concept:** Classical vs molecular concepts of gene; Cis-Trans complementation test.. **Population and evolutionary genetics:** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Practical/Lab work (Core course VII)

- Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
- Chromosome mapping using point test cross data
- Pedigree analysis for dominant and recessive autosomal and sex linked traits.
- Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
- Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

SEMESTER-IV

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Core Course VIII
Molecular Biology (Theory)

UNIT-I	**Nucleic acids as the genetic material:** Historical perspective; Griffith's, Hershey & Chase, Avery, McLeod & McCarty experiments) **The Structures of DNA and RNA/Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, types of DNA, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes; RNA Structure. Chromatin structure- Euchromatin, Heterochromatin , Organisation of eukaryotic chromsosme, Nucleosome,
UNIT-II	**DNA replication:** General principles of DNA replication – bidirectional, semiconservative and semi discontinuous replication; Enzymes involved in DNA replication. Prokasryotic and eukaryotic DNA polymerases, Mechanism of DNA replication of prokaryotes and eukaryotes, telomere shortening and telomerase**,** inhibitors of replication
UNIT-III	**Central dogma and genetic code:** Key experiments establishing-The Central Dogma; Genetic code (deciphering & salient features**)** **Transcription:** RNA polymerase, initiation, elongation and termination of transcription, principles of transcriptional regulation in prokaryotes and eukaryotes: transcription factors; Gene silencing.
UNIT-IV	**Processing and modification of RNA:** Eukaryotic RNA transcription**,** and maturation: introns and exons, removal of introns, spliceosome machinery, RNA splicing, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail). Inhibitors of transcription. **Translation:** Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis **Gene regulation**: Operon concept, induction and repression: Lac operon and Trp operon; and in Eukaryotes.

Practical/Lab work (Core course VIII)

- DNA estimation by diphenylamine reagent/UV Spectrophotometry.
- Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
- Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
- Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter

Suggested Readings

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

Core Course IX
Plant Ecology and Phytogeography (Theory)

UNIT-I	**Introduction:** Basic concepts of ecology; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. **Climatic factors:** Environmental complex, interaction of ecological factors; Light factor; temperature factor; atmospherics –gases; wind factor; fire factor. **Soil factor:** Importance; origin; formation; composition; physical; chemical and biological components; soil profile; role of climate in soil development. **Water:** Importance, states of water in the environment; atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Ecological groups of plants and their adaptations (Hydrophytes, Xerophytes)
UNIT-II	**Biotic interactions:** Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. **Population ecology** Characteristics and Dynamics .Ecological Speciation
UNIT-III	**Plant communities** Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. **Ecosystems:** Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.
UNIT-IV	**Functional aspects of ecosystem** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus. **Phytogeography** Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

Practical/Lab work (Core course IX)
• Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) • Determination of dissolved oxygen of water samples from polluted and unpolluted sources. • Study of morphological adaptations of hydrophytes and xerophytes (four each).

- Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
- Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
- Quantitative analysis of herbaceous vegetation in the college campus for frequency and Comparison with Raunkiaer's frequency distribution law.
- Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
- Field visit to familiarise students with ecology of different sites.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
1. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
4. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Core Course X
Plant Systematics (Theory)

UNIT-I	**Significance of Plant systematics** Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access. **Taxonomic hierarchy** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
UNIT-II	**Botanical nomenclature** Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids. **Systems of classification** Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (up to series) and Engler and Prantl (up to orders). Brief reference of Angiosperm Phylogeny Group (APG III) classification.
UNIT-III	**Study of Angiosperms families:** Ranunculaceae, Brassicaceae, Myrtaceae , Umbelliferae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Cyperaceae, Poaceae
UNIT-IV	**Phylogeny of Angiosperms:** Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Practical/Lab work (Core Course X)
• Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Ranunculaceae - *Ranunculus, Delphinium* Brassicaceae - *Brassica, Alyssum / Iberis* Myrtaceae - *Eucalyptus, Callistemon* Umbelliferae - *Coriandrum /Anethum / Foeniculum* Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax* Solanaceae - *Solanum nigrum/Withania* Lamiaceae - *Salvia/Ocimum* Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha* Liliaceae - *Asphodelus/Lilium/Allium* Poaceae - *Triticum/Hordeum/Avena/Rice* • Field visit (local), Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book)

Suggested Readings

1. Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.* Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.

SEMESTER-V

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Core Course XI
Reproductive Biology of Angiosperms (Theory)

.**UNIT-I**	**Introduction:** History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope. **Anther and Pollen biology:** Anther wall: Structure and functions, microsporogenesis, Microgametogenesis; Pollen wall structure Pollen wall proteins; Pollen viability, storage and germination.
UNIT-II	**Ovule:** Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.
UNIT-III	**Pollination and fertilization:** Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. **Self incompatibility:** Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; *in vitro* fertilization
UNIT-IV	**Embryo, Endosperm and Seed:** Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-

	endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms **Polyembryony and apomixes:** Introduction; Classification; Causes and applications

Practical/Lab work (Core course XI)
• Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation. • Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); • Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous (permanent slides/specimens/photographs); Unitegmic, bitegmic; Tenuinucellate and crassinucellate (permanent slides/specimens/photographs). • Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). • Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Core Course XII:
Plant Physiology (Theory)

UNIT-I	**Plant-water relations:** Water Potential and its components, water absorption by roots, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap cohesion-tension theory. Transpiration and factors affecting transpiration, mechanism of stomatal movement.
UNIT-II	**Mineral nutrition:** Essential and beneficial elements, macro and micronutrients, mineral deficiency symptoms, roles of essential elements, chelating agents. **Nutrient Uptake:** Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems,proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
UNIT-III	**Translocation in the phloem:** Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship. **Plant growth regulators:** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.
UNIT-IV	**Physiology of flowering:** Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. **Phytochrome, crytochromes and phototropins:** Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Practical/Lab work (Core Course XII)
• Determination of osmotic potential of plant cell sap by plasmolytic method. • Determination of water potential of given tissue (potato tuber) by weight method. • Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf. • Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. • To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces). • To study the phenomenon of seed germination (effect of light).

Suggested Readings

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

SEMESTER-VI

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Core Course XIII
Plant Metabolism (Theory)

UNIT-I	**Concept of metabolism:** Introduction, anabolic and catabolic pathways, regulation of metabolism **Carbon assimilation:** Historical background, photosynthetic pigments, role of photosynthetic pigments, antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction.
UNIT-II	**Carbon Oxidation:** Glycolysis, pentose phosphate pathway, TCA cycle, mitichondrial electron transort (ETC), factors affecting respiration. Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, role of uncouplers.
UNIT-III	**Lipid metabolism:** Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.
UNIT-IV	**Nitrogen metabolism :** Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination

Practical/Lab work (Core course XIII)
• Chemical separation of photosynthetic pigments. • To study the effect of light intensity on the rate of photosynthesis. • Effect of carbon dioxide on the rate of photosynthesis. • To compare the rate of respiration in different parts of a plant. • Demonstration of fluorescence by isolated chlorophyll pigments. • Demonstration of absorption spectrum of photosynthetic pigments.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

Core Course XIV
Plant Biotechnology (Theory)

UNIT-I	**Plant Tissue Culture:** Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolites
UNIT-II	**Recombinant DNA technology:** Restriction endonucleases (History, Types I-IV, biological role and application); Cloning Vectors: plasmid, Lambda phage, Cosmid, YAC. **Gene Cloning :** PCR, Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection, colony hybridization.
UNIT-III	**Methods of gene transfer:** *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics , selectable marker and reporter genes (Luciferase, GUS, GFP).
UNIT-IV	**Applications of Biotechnology:** Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Role of transgenics in bioremediation ,Superbug; edible vaccines; Industrial enzymes (Protease, Lipase); Gentically Engineered Products/Geneticaly modified food; Biosafety

Practical/Lab work (Core Course XIV)
• Preparation of MS medium. • Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs. • Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. • Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.

Suggested Readings

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

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

Discipline Specific Elective

Discipline Specific Elective (DSE-I)
Stress Biology (Theory)

UNIT-I	**Defining plant stress:** Acclimation and adaptation.
UNIT-II	**Environmental factors:** Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.
UNIT-III	**Stress sensing mechanisms in plants:** Calcium modulation, Phospholipid signaling, Reactive oxygen species (ROS), production and scavenging mechanisms
UNIT-IV	**Developmental and physiological mechanisms that protect plants against environmental stress:** Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production.

Practical/Lab work (Core Course DSE-I)
• Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress. • Superoxide activity in seedlings in the absence and presence of salt stress. • Zymographic analysis of peroxidase.Zymographic analysis of superoxide dismutase activity. • Quantitative estimation and zymographic analysis of catalase. • Quantitative estimation and zymographic analysis of glutathione reductase. • Estimation of superoxide anions.

Suggested Readings

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

Discipline Specific Elective (DSE-II)
Plant Breeding (Theory)

UNIT-I	**Plant Breeding:** Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding
UNIT-II	**Methods of crop improvement:** Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.
UNIT-III	**Quantitative inheritance:** Concept, mechanism, examples of inheritance of Kernel colour in wheat.monogenic vs polygenic Inheritance.
UNIT-IV	**Inbreeding depression and heterosis:** History, genetic basis of inbreeding depression and heterosis; Applications. **Crop improvement and breeding:** Roles of polyploidy and mutation in crop improvement; Distant hybridization, role of biotechnology in crop improvement.

Practical/Lab work (DSE-II)
• Practical related to theory

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Discipline Specific Elective (DSE-III)
Natural Resource Management (Theory)

UNIT-I	**Natural resources:** Definition and types. Sustainable utilization: concept, approaches (economic, ecological and socio-cultural).
UNIT-II	**Land:** Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. **Water:** Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.
UNIT-III	**Biological Resources:** Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan.
UNIT-IV	**Forests:** Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management. **Energy:** Renewable and non-renewable sources of energy; Waste management; National and international efforts in recourse management and conservation

Practical/Lab work (DSE-III)
• Estimation of solid waste generated by a domestic system (biodegradable and non - biodegradable) and its impact on land degradation. • Collection of data on forest cover of specific area. • Measurement of dominance of woody species by DBH (diameter at breast height) method. • Calculation and analysis of ecological footprint. • Ecological modeling.

Suggested Readings

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

Discipline Specific Elective (DSE-IV)
Biostatistics

UNIT-I	**Biostatistics :** Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.
UNIT-II	**Collection of data primary and secondary:** Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.
UNIT-III	**Measures of central tendency:** Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.
UNIT-IV	**Correlation:** Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression Hypothesis - simple hypothesis - student 't' test - chi square test.

Practical/Lab work (DSE-IV)
• Calculation of mean, standard deviation and standard error • Calculation of correlation coefficient values and finding out the probability • Calculation of 'F' value and finding out the probability value for the F value.

Suggested Readings

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
4. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

Generic Elective Course

Generic Elective I (GE-I)
Biodiversity (Microbes, Algae, Fungi & Archegoniate)
(Theory)

UNIT-I	**Microbes:** Viruses - Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance. Bacteria - Discovery, General characteristics and cell structure; Reproduction - vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.
UNIT-II	**Algae:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia.* Economic importance of algae
	Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium, Alternaria* (Ascornycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; *Mycorrhiza*: ectomycorrhiza and endomycorrhiza and their significance
UNIT-III	**Archegoniate**: Introduction to Archegoniate Unifying features of archegoniates, Transition to land habit, Alternation of generations. **Bryophytes :** General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum.*
UNIT-IV	**Pteridophytes:** General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes. **Gymnosperms**: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included).Ecological and economical importance.

Practical/ Lab work (GE- I)

- Types of Bacteria to be observed from temporary/permanent slides/photographs.
    - bacteria, binary fission, endospore, conjugation, root Nodule
- Gram staining
- Endospore staining with malachite green using the (endospores taken from soil bacteria)
- Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Fucus and Polysiphonia*, temporary preparations and permanent slides.
- Study of vegetative and reproductive structures of **M*archantia, Funaria, Cooksonia,***

Rhynia, Selaginella, Equisetum and Pteris (Permanent slide or temporary slides or live speciemen.)

- ***Cycas***- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
- ***Pinus***- Morphology, transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, longitudinal section of female cone, tangential longitudinal section &radial longitudinal sections stem (permanent slide).
- ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
1. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
2. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
3. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Generic Elective II (GE-II)

Economic Botany and Plant Biotechnology (Theory)

UNIT-I	**Origin of Cultivated Plants:** Concept of centres of origin, their importance with reference to Vavilov's work Cereals: wheat, Origin, morphology and uges Legumes: General account with special reference to Gram and soybean Spices :General account with special reference to clove and black pepper (Botanical name, family, part used)
UNIT-II	**Beverages:** Tea (morphology, processing, uses); Oils and Fats**:** General description with special reference to groundnut **Fibre Yielding Plants:** General description with special reference to Cotton (Botanical name, family, part used)
UNIT-III	**Introduction to plant biotechnology, Plant tissue culture:** Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications
UNIT-IV	**Recombinant DNA Techniques:** Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR.

Practical/ Lab work (GE- II)
• Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests • Familiarization with basic equipments in tissue culture. • Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice.
3. Elsevier Science Amsterdam. The Netherlands. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Skill Enhancement Course

Skill Enhancement Course-I

(SEC-I)

Biofertilisers (Theory)

UNIT-I	General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.
UNIT-II	*Azospirillum:* isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.*Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication
UNIT-III	Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM –its influence on growth and yield of crop plants
UNIT-IV	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – bio-compost making methods, types and method of vermin-composting – field Application.

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad

Skill Enhancement Course-II

(SEC-II)

Ethnobotany (Theory)

UNIT-I	**Ethnobotany:** Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science.The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.
UNIT-II	**Methodology of Ethnobotanical studies:** a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places
UNIT-III	**Role of ethnobotany in modern Medicine:** Medico-ethnobotanical sources in India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Pongamia pinnata* e) *Cassia auriculata* f) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia,Withania*.
UNIT-IV	**Ethnobotany and legal aspects:** Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge

Suggested Readings

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981 Lone et al,. Palaeoethnobotany
3. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, _Lucknow, India.
4. S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur
5. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
6. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra
7. Pradesh, India.Botanical Survey of India. Howrah._8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996
8. Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd.

Skill Enhancement Course-III

(SEC-III)

Mushroom culture Technology (Theory)

UNIT-I	Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*
UNIT-II	Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.
UNIT-III	Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.
UNIT-IV	Food Preparation_:Types of foods prepared from mushroom.Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
5. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Syllabus

B.Sc. BOTANY (Regular)
w.e.f. the Academic Year 2016-2017

Choice Based Credit System (CBCS)

BERHAMPUR UNIVERSITY
BHANJA BIHAR, BERHAMPUR-760007
ODISHA

B. Sc. BOTANY (Regular) under CBCS
w.e.f. the Academic Year2016-2017

Semester - I		Credits
Core-A1	Microbiology and Phycology (Theory)	4
Practical/lab work	Practical/lab work (Core-A1)	2
Core-B1	<From other subject>	6
Core-C1	<From other subject>	6
AECC-I(Ability Enhancement Compulsory Course)	Environmental Studies	2
Semester - II		
Core- A2	Plant Ecology and Taxonomy (Theory)	4
Practical/lab work	Practical/lab work (Core-A2)	2
Core- B2	<From other subject>	6
Core-C2	<From other subject>	6
AECC-II(Ability Enhancement Compulsory Course)	MIL Communication	2
Semester - III		
Core- A3	Plant Anatomy and Embryology (Theory)	4
Practical/ Lab work	Practical/ Lab work (Core-A3)	2
Core- B3	<From other subject>	6
Core- C3	<From other subject>	6
SEC-I(Skill Enhancement Course)	Communicative English	2
Semester - IV		
Core- A4	Plant Physiology and Metabolism (Theory)	4
Practical/ Lab work	Practical/ Lab work (Core-A4)	2
Core- B3	<From other subject>	6
Core- C3	<From other subject>	6
SEC-II (Skill Enhancement Course)	<From the pool of SEC courses>	2
Semester - V		
DSE- A1(Discipline Specific Elective)	Cell and Molecular Biology	4
Practical/ Lab work	Practical/ Lab work (DSE- A1)	2
DSE-B1 (Discipline Specific Elective)	<From other subject>	6
DSE-C1(Discipline Specific Elective)	<From other subject>	6
SEC-III (Skill Enhancement Course)	<From the pool of SEC courses>	2

Semester - VI		
DSE-A2 (Discipline Specific Elective)	Economic Botany and Plant Biotechnology (Theory)	4
Practical/ Lab work	Practical/ Lab work (DSE-A2)	2
DSE-B2(Discipline Specific Elective)	<From other subject>	6
DSE-C2(Discipline Specific Elective)	<From other subject>	6
SEC-IV (Skill Enhancement Course)	<From the pool of SEC courses>	2
	Total	**120**

Skill Enhancement Courses (SEC)

IV. Biofertilsers
V. Ethnobotany
VI. Mushroom Culture Technology

Semester-I

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Core Course

Core Course A1

Microbiology and Phycology

(Theory)

UNIT-I	Introduction to microbial world, microbial nutrition, growth and metabolism.
	Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses. Bacteria: Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination. Economic importance of bacteria
UNIT-II	Algae: General characteristics: distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food, flagella; and methods of reproduction; classification of algae given by Fritsch, significant contributions of important phycologists (F.E. Fritsch and M.O.P. Iyengar). Economic importance of algae. Cyanophyta: General characteristics: distribution, cell structure, ultrastucture, heterocyst, reproduction; Morphology and life-cycle of *Oscillatoria* and *Nostoc*; Economic importance of Cyanophyta.
UNIT-III	Rhodophyta: General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Polysiphonia.* Phaeophyta: Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Fucus*.
UNIT-IV	Xanthophyta: General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of *Vaucheria.* Chlorophyta: General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles, *Volvox, Oedogonium, Coleochaete*. Charophyta: General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*; evolutionary significance.

Practical / Lab work (Core course-A1)

- Types of Bacteria to be observed from temporary/permanent slides/photographs (bacteria, binary fission, endospore, conjugation, root Nodule)
- Gram staining, Endospore staining with malachite green using the (endospores taken from soil bacteria)
- Collection and identification of algae/ fungi from the college/University campus.
- Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Volvox, Oedogonium,Coleochaete, Chara, Vaucheria, Fucus and Polysiphonia,* temporary preparations and permanent slides.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B.(2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

Semester II

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Core Course – A2
Plant Ecology and Taxonomy
(Theory)

UNIT-I	Introduction to ecology, Ecological factors: Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, Precipitation types. Light and temperature: Variation Optimal and limiting factors; Adaptation of hydrophytes and xerophytes
UNIT-II	Plant communities: Characters; Ecotone and edge effect; Succession; Processes and types. Ecosystem: Structure; energy flow; food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous
UNIT-III	Introduction to plant taxonomy; Identification, Classification, Nomenclature. Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.
UNIT-IV	Taxonomic hierarchy: Ranks, categories and taxonomic groups Botanical nomenclature: Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations. Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Practical / Lab work (Core course –A2)
• Determination of pH of two soil samples • Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.

- Study of morphological adaptations of hydrophytes and xerophytes (four each).
- Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
- Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
- Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position
- according to Bentham & Hooker's system of classification):Brassicaceae , Asteraceae, Solanaceae - Liliaceae
- Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book)

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
1. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
2. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Semester III

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Core Course-A3
Plant Anatomy and Embryology
(Theory)

UNIT-I	Meristematic and permanent tissues: Root and shoot apical meristems; Simple and complex tissues. Structure of dicot and monocot root stem and leaf.
UNIT-II	Secondary Growth: Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood). Adaptive and protective systems: Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes
UNIT-III	Structural organization of flower: Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac. Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.
UNIT-IV	Embryo and endosperm: Endosperm types, structure and functions; Dicot and monocot embryo; Embryo and endosperm relationship. Apomixis and polyembryony: Definition, types and practical applications.

Practical/ Lab work (Core Course-A3)
• Study of meristems through permanent slides and photographs. • Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides/photographs) • Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides). • Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides). • Leaf: Dicot and Monocot leaf (only Permanent slides). • Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). • Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/Campylotropous; Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs). • Ultrastructure of mature egg apparatus cells through electron micrographs. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens)

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Semester IV

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Core Course-A4
Plant Physiology and Metabolism
(Theory)

UNIT-I	Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Translocation in phloem: Composition of phloem sap, Phloem loading and unloading
UNIT-II	Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.
UNIT-III	Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Oxidative Pentose Phosphate Pathway. Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation
UNIT-IV	Plant growth regulators: Discovery and physiological roles of auxins, gibberellins,

	cytokinins, ABA, ethylene. Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Practical/ Lab work (Core Course-A4)

- Determination of osmotic potential of plant cell sap by plasmolytic method.
- To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
- Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
- To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
- Comparison of the rate of respiration in any two parts of a plant.
- Separation of amino acids by paper chromatography.

Suggested Readings

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Discipline Specific Elective

SEMESTER V

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Discipline Specific Elective

DSE-A1

Cell and Molecular Biology (Theory)

UNIT-I	Cell as a unit of Life: The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components. Cell Membrane and Cell Wall: The functions of membranes; Models of membrane structure; Faces of the membranes; Selective permeability of the membranes; Cell wall structure and function.
UNIT-II	Cell Organelles: Mitochondria: Structure, marker enzymes, composition; emiautonomous nature, mitochondrial DNA. Chloroplast: Structure, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes: Structures and roles. Peroxisomes and Glyoxisomes:Structures, composition, functions in animals and plants and biogenesis. Nucleus:_Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus
UNIT-III	DNA is a Genetic material: DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming, Ǿ (theta) mode of replication, replication of linear and ds-DNA
UNIT-IV	Transcription (Prokaryotes and Eukaryotes): Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types. Translation (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression: Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes.

Practical/ Lab work (DSE-A1)
1. Study of the photomicrographs of cell organelles 2. To study the plant cell structure through temporary mounts. 3. Study of mitosis and meiosis (temporary mounts and permanent slides). 4. Study the effect of temperature, organic solvent on semi permeable membrane. 5. Demonstration of dialysis of starch and simple sugar. 6. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf. 7. Measure the cell size (either length or breadth/diameter) by micrometry. 8. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene & lampbrush) either by slides or photographs. 9. Study DNA packaging by micrographs. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Semester VI

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Discipline Specific Elective

DSE-A2

Economic Botany and Plant Biotechnology

(Theory)

UNIT-I	Origin of Cultivated Plants: Concept of centres of origin, their importance with reference to Vavilov's work Cereals: wheat, Origin, morphology and uges Legumes: General account with special reference to Gram and soybean Spices :General account with special reference to clove and black pepper (Botanical name, family, part used)
UNIT-II	Beverages: Tea (morphology, processing, uses); Oils and Fats: General description with special reference to groundnut Fibre Yielding Plants: General description with special reference to Cotton (Botanical name, family, part used)
UNIT-III	Introduction to plant biotechnology, Plant tissue culture: Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications
UNIT-IV	Recombinant DNA Techniques: Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse, Transcriptase-PCR.

Practical/ Lab work (DSE-A2)
1. Study of economically important plants: Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical test. 2. Familiarization with basic equipments in tissue culture. 3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation. 4. Study of molecular techniques: PCR, Blotting techniques by Photographs or video

Suggested Readings

4. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
5. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice.
6. Elsevier Science Amsterdam. The Netherlands. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Skill Enhancement Course

Skill Enhancement Course-I
(SEC-I)
Biofertilisers (Theory)

UNIT-I	General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.
UNIT-II	*Azospirillum:* isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.*Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication
UNIT-III	Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM –its influence on growth and yield of crop plants
UNIT-IV	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – bio-compost making methods, types and method of vermin-composting – field Application.

Suggested Readings

7. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
8. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
9. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, New Delhi.
10. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
11. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
12. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad

Skill Enhancement Course-II
(SEC-II)
Ethnobotany (Theory)

UNIT-I	**Ethnobotany:** Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science.The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.
UNIT-II	**Methodology of Ethnobotanical studies:** a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places
UNIT-III	**Role of ethnobotany in modern Medicine:** Medico-ethnobotanical sources in

	India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Pongamia pinnata* e) *Cassia auriculata* f) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia,Withania*.
UNIT-IV	**Ethnobotany and legal aspects:** Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge

Suggested Readings

9. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
10. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981 Lone et al,. Palaeoethnobotany
11. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, _Lucknow, India.
12. S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur
13. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
14. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra
15. Pradesh, India.Botanical Survey of India. Howrah._8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996
16. Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd.

Skill Enhancement Course-III

(SEC-III)

Mushroom culture Technology (Theory)

UNIT-I	Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*
UNIT-II	Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.
UNIT-III	Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.
UNIT-IV	Food Preparation_:Types of foods prepared from mushroom.Research Centres - National level and Regional level._Cost benefit ratio - Marketing in India and abroad, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991).Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition