KHALLIKOTE UNIVERSITY,

BERHAMPUR-760001, ODISHA

SYLLABUS

U.G. (Botany)

2017

P.G.DEPARTMENT OF BOTANY

KHALLIKOTE AUTONOMOUS COLLEGE,

BERHAMPUR-760001, ODISHA

COURSE STRUCUTRE FOR UG SCIENCE UNDER CBCS

SEM	Core course (14) A	AECC(2) Compulsory B	AECC(2) Skill Based C	DSE(4) D	GE(4) E	Credits	Marks
I S	CORE-1	MIL (O/H/T/E)			GE-1 Minor-1	20	350
	CORE-2						
II S	CORE-3	EVS			GE-2 Minor-2	20	350
	CORE-4						
III S	CORE-5		SEC-I Communicative English and writing Skill (Comp.)		GE-3 Minor-1	26	450
	CORE-6						
	CORE-7						
IV S	CORE-8		SEC-II Subject Specific Skill		GE-4 Minor-2	26	450
	CORE-9						
	CORE-10						
V S	CORE-11			DSE-1 DSE-2		24	400
	CORE-12						
VI S	CORE-13			DSE-3 DSE-4		24	400
	CORE-14						
TOTAL	84Credits/ 1400 marks	04 credits 100 marks	04 credits 100marks	24 credits 400marks	24credits 400marks	140	2400

FOR SCIENCE COURSES

A. Core course =Hons 14 papers 100x14 =1400 marks (56 credits)

B. **AECC** (Ability Enhancement Compulsory Course)= MIL (O/H/T/E) AND EVS

C. **SEC-1 :** to be taught by English Department and **SEC-II** will be Adv.Biotech/Adv.Chem/Applied Phys/ Modern Math and not same as Core subject. Syllabus for SEC-II is to be prepared by Deptt./BOS for 50marks(40+10 marks) with four units, Exams. Will be for 2 hours duration.

D. **DSE 1 to 4 :** Spl. Hons, Papers to be selected from syllabus given by Utkal Univ. DSE-4 can be Research methodology/Theory/Practical/projects/field tour as decided by Deptt./BOS

E. **GE-1 to 4** (two subjects, Minor-1&Minor-2)

Choose any two from Bot /Chem /Phys/Math/Zool. Expect Core Subject

Try to change the title of the course by keeping course content same .

Practicals in SemesterI, II , V and VI can be combined into one practical of 50 marks and 6 hr duration. For Semester III and IV ,there can be one practical of 75 marks and 6hr duration.

DETAILED COURSE STRUCTURE FOR SCIENCE (BOTANY) underCBCS, 2017-18

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS	MARKS
FIRST SEMESTER	Ability Enhancement Course-I	MIL (O/H/T/E)	02	50
	CORE-1 Theory	Microbiology and phycology	04	75
	CORE-2 Theory	Biomolecules and Cell Biology	04	75
	PRACTICAL FOR CORE -1 AND CORE-2	Microbiology and phycology Biomolecules and Cell Biology	04	50
	Generic Elective-I Theory **Practical**	Molecular Biology and Biodiversity of life	04+02	75+25
FIRST SEMESTER		**TOTAL**	**20 credits**	**350 marks**
SECOND SEMESTER	Ability Enhancement Course-II	EVS	04	100
	CORE-3 Theory	Mycology & Phytopathology	04	75
	CORE-4 Theory	Archegoniate	04	75
	PRACTICAL FOR CORE -3 AND CORE-4	Mycology & Phytopathology Archegoniate	04	50
	Generic Elective-II Theory **Practical**	Diversities in Land Plants	04+02	75+25
SECOND SEMESTER		**TOTAL**	**22 credits**	**400 marks**
THIRD SEMESTER	CORE-5 Theory	Anatomy of angiosperm	04	75
	CORE-6 Theory	Economic Botany	04	75
	CORE-7 Theory	Genetics	04	75
	PRACTICAL FOR CORE -5, CORE-6 AND CORE-7		06	75
	SEC-I	Communicative English & writing Skill	04	100
	Generic Elective-III Theory **Practical**	Plant and human Welfare, Basic Biotechnology	04+02	75+25
THIRD SEMESTER		**TOTAL**	**28 credits**	**500 marks**

IMPORTANT NOTE: About practical examinations

First semester: ONE Practical for CORE-1 and CORE-2 =50 marks (6 hr)

Second semester: ONE Practical for CORE-3 and CORE-4 =50 marks (6 hr)

Third semester: ONE Practical for CORE-5, CORE-6 and CORE-7 =75 marks (6 hr)

Fourth semester:ONE Practical for CORE-8, CORE_9 and CORE-10 =75 marks (6 hr)

Fifth semester: ONE Practical for CORE-11 and CORE-12 =50 marks (6 hr)

Sixth Semester: ONE Practical for CORE-13 and CORE-14 =50 marks (6 hr)

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS	MARKS
FOURTH SEMESTER	CORE-8 Theory	Molecular Biology	04	75
	CORE-9 Theory	Ecology	04	75
	CORE-10 Theory	Plant Systematics	04	75
	PRACTICAL FOR CORE -8, CORE-9 AND CORE-10		06	75
	SEC-II	Applied Biotechnology	04	100
	Generic Elective-IV Theory Practical	Zoology - 02	04+02	75
FOURTH SEMESTER		**TOTAL**	**26credits**	**450 marks**
FIFTH SEMESTER	CORE-11 Theory	Reproductive Biology of Angiosperms	04	75
	CORE-12 Theory	Plant Physiology	04	75
	PRACTICAL FOR		04	50

	CORE -11 AND CORE-12			
	DSE-1 Theory Practical	Natural resource management	06	100
	DSE-2 Theory Practical	Biostatistics	06	100
	PRACTICAL FOR DSE -1 AND DSE-2			
FIFTH SEMESTER		**TOTAL**	**24credits**	**400 marks**
SIXTH SEMESTER	CORE-13 Theory Practical	Plant Metabolism	04	75
	CORE-14 Theory Practical	Plant Biotechnology	04	75
	PRACTICAL FOR CORE -13 AND CORE-14		04	50
	DSE-3 Theory Practical	Stress Biology	06	100
	DSE-4 :PROJECTS		06	100
SIXTH SEMESTER		**TOTAL**	**24 credits**	**400 marks**

THEORY-75 marks (60 Term End+15 Internal Assessment)

THEORY-50 marks (40 Term End+10 Internal Assessment)

SEMESTER-I BOTANY CORE

Core Course I: Microbiology and Phycology 100 marks (Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

UNIT –I	**Introduction to microbial world** **Viruses**:-Discovery,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	**7 lectures**
	Bacteria: - Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria	**5 lectures**
UNIT– II	**Algae:-** General characteristics; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, T.V. Desikachary , M.O.P. Iyengar).Economic importance of algae.	**6 lectures**
UNIT- III	**Cyanophyta:-** Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction. Morphology and life-cycle of *Nostoc*	**5 lectures**
	Chlorophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete.*	**5 lectures**
UNIT -IV	**Charophyta:-** General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*.	**2 lectures**
	Xanthophyta:- General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of *Vaucheria*	**3 lectures**
	Phaeophyta:- Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Fucus*	**3 lectures**
	Rhodophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Polysiphonia.*	**4 lectures**

BOTANY CORE

PRACTICAL (20 CLASSES 2 HOURS EACH)

MICROBIOLOGY	1. Electron micrographs/Models of viruses - T-Phage and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle. 2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule. 3. Gram staining. 4.Endospore staining (endospores taken from soil bacteria)
PHYCOLOGY	Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* ,Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, 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, NewDelhi.
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-I BOTANY CORE

Core Course II: Biomolecules and Cell Biology-100 marks(Credits-6:Theory-4,Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes

UNIT -I	**Biomolecules:-** Types and significance of chemical bonds; Structure and properties of water; pH and buffers.	**2 lectures**
	Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols - mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage -starch, insulin)	**3 lectures**
	Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties	**3 lectures**
	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	**3 lectures**
	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	**4 lectures**
UNIT-II	**Bioenergenetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions.ATP: structure, its role as a energy currency molecule.	**3 lectures**
	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.	**4 lectures**
UNIT-III	**Cell and Cell organelle:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).	**2 lectures**
	Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport - Passive, active and facilitated transport, endo cytosis and exocyosis.	**3lectures**
	Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament **Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.	**4 lectures**
	Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	**2 lectures**
UNIT - IV	**Nucleus;** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. **Cell division:** Eukaryotic cell cycle, different stages of mitosis and meiosis. Regulation of cell cycle.	**7 lectures**

BOTANY CORE

PRACTICALS(20 CLASES OF 2 hours duration)

PRACTICALS	1.Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins 2.Study of plant cell structure with the help of epidermal peel mount o *Onion/Rhoeo/Crinum*.f 3.Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf. 4.Measurement of cell size by the technique of micrometry. 5.Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains) 6.Study of cell and its organelles with the help of electron micrographs. 7.Study the phenomenon of plasmolysis and deplasmolysis. 8.Study different stages of mitosis and meiosis using aceto carmine and aceto orcine methods

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. Freemanand 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 Fra

SEMESTER-II BOTANY CORE

<u>Core Course III</u>: Mycology and Phytopathology – 100 marks (Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction to true fungi:** Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification. **Chytridiomycetes:** General account	**5 lectures**
	Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus.*	**2 lectures**
	Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Aspergillus, Penicillium, Alternaria* and *Neurospora,*.	**7 lectures**
Unit-II	**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;*.	**5 lectures**
	Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora.*	**4 lectures**
Unit-III	**Symbiotic associations:** Lichen - General characteristics; range of thallus organization;Types of Lichen Nature of associations of algal and fungal partners; Reproduction.Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.	**5 lectures**
	Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry (Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers).	**5 Lectures**
Unit-IV	**Phytopathology:** Terms and concepts; General symptoms; etiology; symptomology; Host- Pathogen interaction; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases - Citrus canker and angular leaf spot disease of Cotton. Viral diseases - Tobacco Mosaic disease,Vein clearing. Fungal diseases - Black stem rust of wheat, white rust of crucifers	**7 lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2HOURS)

PRACTICALS	1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps &basidiocarps). 2. *Rhizopus:* study of asexual stage from temporary mounts and sexual structures through permanent slides. 3. *Aspergillus* and *Penicillium:* study of asexual stage from temporary mounts. Study ofSexual stage from permanent slides/photographs *4.Alternaria:* Specimens/photographs and temporary mounts. 5.*Puccinia:* Herbarium specimens of Black Stem Rust of Wheat and infectedBarberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts. 6.*Agaricus:* Specimens of button stage and full grown mushroom; sectioning of gills of*Agaricus,* fairy rings and bioluminescent mushrooms to be shown. 7.*Albugo:* Study of symptoms of plants infected with *Albugo;* asexual phase study through section/ temporary mounts and sexual structures through permanent slides. 8. 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 endo mycorrhiza (Photographs)

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. 3rdedition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers IndiaLtd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, Indi

SEMESTER-II BOTANY CORE

Core Course IV: Archegoniate - 100 marks (Credits-6 Theory-4, Practical 2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory +20 Practical classes]

Unit-I	**Introduction:** Unifying features of archegoniates; Transition to land habit; Alternation of generations. Types of life cycles, Sporophytic generation, gametophytic generation.	**2 lectures**
	Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization.Classification (up to family).*Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria;* Reproduction and evolutionary trends in Riccia, Marchantia , Anthoceros and Funaria (developmental stages not included). Ecological and economic importance of bryophytes.	**12 lectures**
Unit-II	**Pteridophytes:** General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *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.	**10 lectures**
Unit-III	**Gymnosperms:** General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo* and *Gnetum.* (Developmental details not to be included). Ecological and economic importance.	**8 lectures)**
Unit-IV	**Fossils:** Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia, Calamites, Lepidodendron, Lyginopteris* and *Cycadeoidea.*	**8 lectures**

PRACTICAL(20CLASSES OF 2 HOURS duration) **BOTANY CORE**

PRACTICAL	***Riccia*** - Morphology of thallus. ***Marchantia-*** Morphology of thallus, whole mount of Gemmae (all temporary slides), longitudinal section of Sporophyte (all permanent slides). ***Anthoceros-*** Morphology of thallus, dissection of sporophyte (temporary slide), vertical section of thallus (permanent slide). ***Pellia, Porella-*** Permanent slides. ***Sphagnum-*** Morphology of plant, whole mount of leaf (permanent slide only). ***Funaria-*** Morphology, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, and protonema. .***Psilotum-*** Study of specimen, transverse section of synangium (permanent slide). ***Selaginella-*** Morphology, whole mount of leaf with ligule, transverse section of stem, longitudinal section of strobilus (permanent slide . ***Equisetum-*** Morphology, transverse section of internode, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slides) ***Pteris-*** Morphology, transverse section of rachis, transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide). ***Cycas-*** Morphology (coralloid roots, bulbil, leaf), transverse section of coralloid root, transverse section of rachis, longitudinal section of ovule, transverse section of root (permanent slide). ***Pinus-*** Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stemlongitudinal 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.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, NewDelhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot.Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

SEMESTER-III BOTANY CORE

Core Course V: Anatomy of Angiosperms - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours) [75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction and scope of Plant Anatomy:** Applications in systematics, forensics and pharmacognosy.	**2 lectures**
	Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements;Pits and plasmodesmata. **Secretory System:** Hydathodes, cavities, lithocysts and laticifers.	**8 Lectures**
Unit-II	**Stem:** Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Types of vascular bundles; Structure of dicot and monocot stem.	**5 Lectures**
	Leaf: Structure of dicot and monocot leaf, Kranz anatomy.	**4 lectures**
	Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescentcentre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.	**4 Lectures**
Unit-III	**Vascular Cambium:** Structure, function and seasonal activity of cambium; Secondary growth in root and stem.	**4 Lectures**
	Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.	**5 Lectures**
	Periderm: Development and composition of periderm, rhytidome and lenticels.	**3 Lectures**
Unit -IV	**Adaptive and Protective Systems** Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification);Anatomical adaptations of xerophytes and hydrophytes.	**5 Lectures**

BOTANY CORE

PRACTICALS (20CLASSES OF 2 HOURS duration)

PRACTICALS	1. Study of anatomical details through permanent slides/temporary stainmounts/macerations/ museum specimens with the help of suitable examples. 2. Apical meristem of root, shoot and vascular cambium. 3. Distribution and types of parenchyma, collenchyma and sclerenchyma. 4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates;xylem fibres. 5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood. 6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres. 7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular. 8. Root: monocot, dicot, secondary growth. 9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. 10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). 11. Adaptive Anatomy: xerophytes, hydrophytes. 12. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA
4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

SEMESTER-III BOTANY CORE

Core Course VI: Economic Botany - 100 marks (Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

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 diversty.	**3 lectures**
	Cereals : Wheat and Rice (origin, morphology, processing & uses), brief account of millets.	**3 lectures**
	Legumes: General account, importance to man and ecosystem.	**3 lectures**
	Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato - morphology, propagation & uses.	**3 lectures**
Unit-II	**Spices:** Listing of important spices, their family and part used, economic importance with specialreference to fennel, saffron, clove and black pepper	**4 lectures**
	Beverages: Tea, Coffee (morphology, processing &uses)	**4 lectures**
	Drug-yielding plants: Therapeutic and habit-forming drugs with specialreference to *Cinchona, Digitalis, Papaver andCannabis.*	**4 lectures**
	Tobacco: Tobacco (Morphology, processing, uses and health hazards)	**2 lectures**
Unit-III	**Oils & Fats:** General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* and Coconut (Botanical name, family & uses)	**4 lectures**
	Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.	**4 lectures**
Unit-IV	**Natural Rubber:** Para-rubber: tapping, processing and uses.	**2 lectures**
	Timber plants: General account with special reference to teak and pine.	**2 Lectures**
	Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).	**2 lectures**

PRACTICALS (20 CLASSES OF 2 HOURS DURATION)

PRACTICALS	**1. Cereals:** Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests). **2. Legumes:** Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests). **3. Sugars & Starches:** Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests). **4. Spices:** Black pepper, Fennel and Clove (habit and sections). **5. Beverages:** Tea (plant specimen, tea leaves), Coffee (plant specimen, beans). **6. Oils & Fats:** Coconut- T.S. nut, Mustard-plant specimen, seeds; tests for fats incrushedseeds. **7. Essential oil-yielding plants:** Habit sketch of*Rosa,* V*etiveria, Santalum* and *Eucalyptus*(specimens/photographs). **8. Rubber:** specimen, photograph/model of tapping, samples of rubber products. **9. Drug-yielding plants:** Specimens of *Digitalis, PapaverandCannabis.* **10. Tobacco:** specimen and products of Tobacco. **11. Woods:** Tectona, Pinus: Specimen, Section of young stem. **12. Fibre-yielding plants:** Cotton (specimen, whole mount of seed to show lint andfuzz;whole mount of fibre and test for cellulose), Jute (specimen, transverse sectionof stem, test for lignin on transverse section of stem and fibre).

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. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publisher

SEMESTER-III BOTANY CORE

Core Course VII: Genetics - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Mendelian genetics and its extension** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.	**10 lectures**
Unit-II	**Extrachromosomal Inheritance:** Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*	**6 lectures**
Unit-III	**Linkage, crossing over and chromosome mapping:** Linkage and crossing over, cytological basis of crossing over; Types of crossing over, recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage. **Variation in chromosome number and structure:** Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy	**12 lectures**
Unit-IV	**Fine structure of gene:** Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus. **Gene mutations:** Types of mutations; Molecular basis of Mutations; Mutagens - physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation.DNA repair mechanisms.	**12lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2 HOURS DURATION)

PRACTICALS	1. Meiosis through temporary squash preparation. 2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis. 3. Chromosome mapping using test cross data. 4. Pedigree analysis for dominant and recessive autosomal and sex linked traits with floral chart. 5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4). 6. Blood Typing: ABO groups & Rh factor.

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. 5thedition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th 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 BOTANY CORE

Core Course VIII: Molecular Biology - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

UNIT-I	**Nucleic acids : Carriers of genetic information:** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.	**4 lectures**
UNIT-II	**The Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, .RNA Structure- Organelle DNA -mitochondria and chloroplast DNA.The Nucleosome - Chromatin structure-Euchromatin, Heterochromatin.	**8 lectures**
	The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles - bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, Enzymes involved in DNA replication.	**6 lectures**
UNIT-III	**Central dogma and genetic code:** Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of m RNA template), Genetic code (deciphering & salient features)	**2 lectures**
	Mechanism of Transcription: Transcription in prokaryotes; Transcription in eukaryotes.	**4 lectures**
	Split genes-concept of introns and exons, RNA splicing and spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes, exon shuffling.	**5 lectures**
UNIT-IV	**Translation (Prokaryotes and eukaryotes):** 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.	**6 lectures**
	Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptional regulation; Prokaryotes: Regulation of lac-operon and trp-operon	**5 lectures**

PRACTICALS (20 CLASSES OF 2 HOURS EACH)

PRACTICALS	1. Preparation of LB medium and raising *E.Coli.* 2. RNA estimation by orcinol method. 3. DNA estimation by diphenylamine reagent/UV Spectrophotometry. 5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication). 6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs. 7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) 8.Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology ofthe Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th
edition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings.U.S.A. 9th edition.

4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W.H. Freeman and Co., U.S.A. 10th edition

SEMESTER-IV BOTANY CORE

Core Course IX: Plant Ecology and Phytogeography - 100 marks (Credits-6: Theory-4, Practical-2) Theory (each class 1 hour) PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction** Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environmental, concept of hydrosphere and lithosphere and dynamism, homeostasis.	**5 lectures**
	Soil: Importance; Composition; Physical; Chemical and Biological components; Soil profile;	**2 lectures**
	Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.	**2 lectures**
	Light, temperature, wind and fire: Variations; adaptations of plants to their variation.	**4 lectures**
Unit-II	**Population ecology:** Characteristics and Dynamics .Ecological Speciation	**5 lectures**
	Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession - processes, types; climax concepts.	**5 lectures**
Unit-III	**Ecosystems:** Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.	**5 lectures**
	Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.	**5 lectures**
Unit-IV	**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.	**7 lectures**

BOTANY CORE

PRACTICALS	1. Determination of pH of various soil and water samples (pH meter,universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats. 4. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 5(a). Study of morphological adaptations of hydrophytes and xerophytes (four each). (b). Study of biotic interactions of the following: Stem parasite *(Cuscuta),* Root parasite*(Orobanche)* Epiphytes, Predation (Insectivorous plants). 6.Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed). 7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 8.Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 9. Field visit to familiarize 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.

3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

SEMESTER-IV BOTANY CORE

Core Course X: Plant Systematics – 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant identification, Classification, Nomenclature; Biosystematics**	**2 lectures**
	Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access	**6 lectures**
Unit-II	**Taxonomic hierarchy:** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).	**6 lectures**
	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	**6 lectures**
Unit-III	**Systematics- an interdisciplinary science:** Evidence from palynology, cytology, phytochemistry and molecular data.	**6 lectures**
	Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm	**6 lectures**
Unit-IV	**Phylogeny of Angiosperms:** Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).origin& evolution of angiosperms; coevolutionof angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	**8 lectures**

Practical (20 classes, each class of 2h)

Practical	1. 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* 2. Field visit (local) – Subject to grant of funds from the university. 3. 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, G. (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.

Core Course XI:Reproductive Biology of Angiosperms-100 marks(Credits-6:Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks(Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

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.	**2 lectures**
	Anther: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.	**2 lectures**
	Pollen biology: Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.	**5 lectures**
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.	**5 lectures**
	Endosperm: Types, development, structure and functions.	**3 lectures**
	Embryo: Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo;Unusual features; Embryo development in *Paeonia.*	**6 lectures**
Unit-III	**Pollination and fertilization:** Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.	**4 lectures**
	Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility: mixed pollination, bud pollination,	**7 lectures**
Unit-IV	**Seed:** Structure, importance and dispersal mechanisms	**3 lectures**
	Polyembryony and apomixes: Introduction; Classification; Causes and applications.	**4 lectures**
	Germline transformation: Pollen grain and ovules through pollen tube pathway method.	**2 lectures**

Practical (20 classes, each class of 2h)

Practical	1. 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. 2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Calculation of germination in different media using hanging drop method. 3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). 4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus. 5. Intra-ovarian pollination; Test tube pollination through photographs. 6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria. 7. 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, Netherland

SEMESTER-V BOTANY CORE

Core Course XII: Plant Physiology - 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours
[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant water relationship**: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast,- and apoplastic pathways, root pressure, guttation. Ascent of sap- cohesion-tension theory. Transpiration and factors affecting transpiration, anti transpirants, mechanism of stomatal movement.	**6 lectures**
	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.	**5 lectures**
Unit-II	**Mineral nutrition:** Essential and beneficial elements, macro , micro and trace nutrients, hydroponics, aeroponics(geoponics), mineral deficiency symptoms, roles of essential elements, chelating agents.	**5 lectures**
Unit-III	**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.	**5 lectures**
Unit-IV	**Plant growth regulators:** Bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene.	**10 lectures**
	Physiology of flowering: Photoperiodism, florigen concept, vernalization, seed dormancy.	**4 lectures**
	Phytochrome: Role of phytochrome in photomorphogenesis,.	**5 lectures**

Practical (20 classes, each class of 2h)

Practical	1. Determination of osmotic potential of plant cell sap by plasmolytic method. 2. Determination of water potential of given tissue (potato tuber) by weight method. 3. Study of the effect of light on the rate of transpiration in excised twig/leaf. 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. 5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces). 6. To study the phenomenon of seed germination (effect of light). 7. To study the induction of amylase activity in germinating barley grains. **Demonstration experiments** 1. To demonstrate suction due to transpiration. 2. Fruit ripening/Rooting from cuttings (Demonstration). Bolting experiment/*Avena* coleptile bioassay (demonstration)

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., M0ller, I.M. and Murphy, A (2015). Plant Physiology and Development .Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual Narosa Publishing House, New Delhi.

Core Course XIII: Plant Metabolism - 100 marks (Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)[
75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Concept of metabolism:** Introduction, anabolic and catabolic pathways,regulation of metabolism, role of regulatory enzymes (allosteric and Isozymes).	**5 lectures**
	Carbohydrate metabolism: Synthesis and catabolism of starch. **Lipid metabolism:** Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α- oxidation.	**6 lectures**
Unit-II	**Carbon assimilation:** Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4 pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.	**10 lectures**
Unit-III	**Carbon Oxidation:** Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, NADH shuttle; TCA cycle, mitochondrial electron transport, oxidative phosphorylation, factors affecting respiration.	**6 lectures**
	ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase,	**5 lectures**
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.	**8 lectures**

Practical (20 classes, each class of 2h)

Practical	1. Chemical separation of photosynthetic pigments. 2. Experimental demonstration of Hill's reaction. 3. To study the effect of light intensity on the rate of photosynthesis. 4. Effect of carbon dioxide on the rate of photosynthesis. 5. To compare the rate of respiration in different parts of a plant.. 6. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination. 7.Demonstration of fluorescence by isolated chlorophyll pigments. 8. 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., M0ller, I.M. and Murphy, A (2015). Plant Physiology and Development. SinauerAssociates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

Core Course XIV: Plant Biotechnology - 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15+ End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant Tissue Culture:** Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones).	**3 lectures**
	Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).	**7 lectures**
Unit-II	**Recombinant DNA technology-I:** Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector;Eukaryotic Vectors (YAC) Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).	**10 lectures**
Unit-III	**Recombinant DNA technology-II:** Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain geneof interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; 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).	**10 lectures**
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); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products-Human Growth Hormone; Humulin; Biosafety concerns.	**10 lectures**

PRACTICALS (20 CLASSES OF 2 HOURS EACH)

PRACTICALS	1. (a) Preparation of MS medium. (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura, Brassica* etc. 2.Study of anther, embryo and endosperm culture, micro propagation, somatic Embryogenesis & artificial seeds through photographs. 3. Construction of restriction map of circular and linear DNA from the data provided. 4. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 5. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savrtomato through photographs. 6.Restriction digestion and gel electrophoresis of plasmid DNA.(Demonstration)

SUGGESTED READINGS

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications Of recombinant DNA. ASM Press, Washington.
4. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication HousePvt. Ltd., New Delhi. 5th edition.
5. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5thedition.
6. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
7. Chawla, H.S. (2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co.Pvt Ltd., New Delhi.
7. Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi

Discipline Specific Elective Courses (DSE)

Semester-V

Discipline Specific Elective (DSE –1): Analytical Techniques in Plant Sciences – 100 marks (Credits-6:)THEORY (Each class 1 hour): [100 marks (Mid Sem 20+ End Sem 80)]Lectures: 40 Theory

Unit –I	**Imaging and related techniques:** Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching	**8 lectures**
Unit –II	**Cell fractionation:** Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.	**6 lectures**
	Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.	**4 lectures**
Unit–III	**Spectrophotometry:** Principle and its application in biological research.	**4 lectures**
	Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE	**6 lectures**
Unit–IV	**Biostatistics:** Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit	**12 lectures**

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co.

Ltd. New Delhi. 3rd edition.

2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995).

Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.

4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

SEMESTER-V

Discipline Specific Elective (DSE –2) : Biostatstics – 100 marks(Credits-6) THEORY (Each class 1 hour): [100 marks (Mid Sem 20 + End Sem 80)]Lectures: 40 Theory

Unit –I	Biostatistics - definition - statistical methods - basic principles. Variables -measurements, functions, limitations and uses of statistics.	**8 lectures**
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.	**8 lectures**
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.	**10 lectures**
Unit –IV	Correlation - types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression	**8 lectures**
	Statistical inference - hypothesis - simple hypothesis - student 't' test – chi square test.	**6 lectures**

SEMESTER-VI

Discipline Specific Elective (DSE –3):Stress Biology – 100 marks(Credits-6THEORY (Each class 1 hour):[100 marks (Mid Sem 20 + End Sem 80)]Lectures: 40 Theory

Unit –I	**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.	**12 lectures**
Unit –II	**Stress sensing mechanisms in plants:** Role of nitric oxide. Calcium modulation, Phospholipid signaling	**12 lectures**
Unit –III	**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.	**10 lectures**
Unit –IV	**Reactive oxygen species –** Production and scavenging mechanisms. Acclimation and adaptation of plants.	**6 lectures**

FIRST SEMESTER: MINOR-1 GE-I (Botany)

F.M 75+25=100(04 +02 credits) Duration of Exam: 3 hours

Minor –I Generic Elective-1 (Bio-molecules and Biodiversity in life)

Unit –I	**Cell ,Molecular Biology and Genetics** Ultra-structure of a typical plant cell and its organelles. cell division,types and significance Structure and types of DNA , DNA Replication in Prokaryotes ,Principles of inheritance, Mendel's laws of inheritance,Cytoplasmic inheritance in *Mirabillis* and Snail. Mutation ,Ploidy (Aneuploidy and euploidy)	**Periods :10**
Unit –II	**Microbiology, Phycology ,Mycology& Pathology** **Viruses**: Structure of TMV and bacteriophage , replication of bacteriophages (Lytic and Lysogenic cycle) **Bacteria**: Structure, nutrition, reproduction, recombination, economic importance, **Phycology:** Thallus organisation reproduction and economic importance of algae, and life cycle of the following genera: *Chlamydomonas,Oedogonium, Chara, Vaucheria, Polysiphnia,* **Mycology:** General characteristics of fungi: life cycle of the following genera: *Rhizopus , Penicillium, Puccinia,* **Pathology**: Symptoms, causative organism, and control measures of the following diseases- Damping off of seedlings, Mildew of Pea, Rust of Wheat**.(No developmental stages necessary for life cycle)**	**Periods :10**
Unit –III	**Diversities in Land Plants** **Bryophytes**: General features of Bryophytes, morphology,anatomy , reproduction and life cycle of *Marchantia, Anthoceros, Sphagnum.* **Pteridophytes:** General features of Pteridophytes, morphology, anatomy, reproduction and life cycle of *Selaginella, Equisetum, Marsilea.* **Gymnosperm**: General features of Gymnosperm, morphology, anatomy, reproduction and life cycle of *Cycas, Pinus* and *Gnetum.* **.(No developmental stages necessary for life cycle)**	**Periods :10**
Unit –IV	**Anatomy and Embryology** Tissues: Meristematic and Permanent tissues,Shoot apex organization and the theories related to it,Normal and anomalous secondary growth, Microsporogenesis, megasporogenesis, development of male and female gametophyte, Pollination and fertilization, Types of endosperms, development of typical dicot and monocot embryo.	**Periods :10**

BOTANY

General elective - I

PRACTICAL (20 CLASSES 2 HOURS EACH)

Microbiology, Phycology ,Mycology& Pathology	1. Electron micrographs/Models of viruses - T-Phage and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle. 2. Gram staining. 3. Study of vegetative and reproductive structures of *Chlamydomonas* ,*Oedogonium, Chara, Vaucheria, and Polysiphonia,* temporary slide preparations.
Cytology	Microgrphic stydy of :- Prokaryotic DNA replication, 3D structure of different types iof DNA
Diversities in Land Plants, Anatomy and Embryology.	Permanent slides of Bryophytes,Pteridophytes & Gymnosperms. Stem of dicotyledonos plant with abnormal secondary growth fetures. Embryological permanent slides

Suggested Readings

5. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
6. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
7. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press,Delhi.
8. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, NewDelhi.
9. The embryology of angiosperms.
10. B.P.Pandey (2010) Anatomy of plants

THIRD SEMESTER: MINOR-1 GE-II (Botany)

F.M 75+25=100(04 +02 credits) Duration of Exam: 3 hours

Minor –I Generic Elective-II (Plant and Human Welfare, Plant physiology and Biostatistics)

Unit –I	**Systematics and Economic Botany:** Artificial, natural and phylogenetic system of classification, Economic uses of the following plants in relation to human welfare (in form of short notes) with reference to rice, black gram, mustard, cotton, coffee, Cinchona, Ocimum.	**Periods :6**
Unit –II	**Plant Physiology** **Photosynthesis** : Light & Dark reaction,Mechanism of photophosphorylation; Path of carbon , C_3, C_4 and CAM cycle , **Respiration**; glycolysis , TCA cycle ,electron transport system , Mechanism of oxidative phosphorylation ,hexose monophosphate shunt, **Nitrogen fixation**: symbiotic and non-symbiotic mechanism, , phases of growth, **Phytohormones**: discovery, physiological role of Auxins, Gibberellins, cytokinins and ABA. **Flowering**: Photoperiodism and vernalization.	**Periods :14**
Unit –III	**Environmental Biology** Environment and its components. Communities and their characteristics. **Ecosystems**: Concepts, structure and function of ecosystem; energy flow, bio-geo chemical cycles. Renewable and non-renewable energy resources and their management. Pollution of air, water, soil, noise, and their control and prevention. Global warming, Acid rain and Ozone depletion.	**Periods :10**
Unit-IV	**Biostatistics** Need of statistics in biology, collection of biological data, central tendency- mean, median, mode and their biological significance, dispersion, mean deviation, variance, standard deviation and their biological imporantance, Estimation and hypothesis testing, student's t –test and Chi-square test and their application	**Periods :10**

Internal Assessment: Home Assignment submission

BOTANY

General elective - II

PRACTICAL (20 CLASSES 2 HOURS EACH)

Systematics and Economic Botany:	**Taxonomy of plants belonging to :-** Rubiaceae, Apocynaceae, Asclepiadaceae, Asteraceae solanaceae, Lamiaceae, Brassicaceae And Liliaceae **Economic importance of :-** Rice, Black gram, Mustard, Cotton, Coffee, Cinchona & Ocimum.
Plant Physiology	Determination of osmotic pressure of vacular cells of epidermid of Rhoeo discolor leaf by plasmolytic method, Determination of OP of Root / Stem tuber.
Environmental Biology & Biostatistics	Central tendency, Standard Deviation & chi square test

Suggested Readings

1. Systematic botany and Economic Botany by Sing ,Pandey Jain
2. Plant physiology by Arun Chandra Sahu
3. Perspectives in Ecology & Biostatistics by Mandeep Raj & Rajan Sharma

FOURTH SEMESTER: SEC-II F.M 80+20=100(04 credits)

Subject Specific Skill (SEC-II) : Applied Biotechnology (40 periods)

Unit –I	**Genetic Engineering** Structure and Biological importance of DNA and RNA , DNA replication in prokaryotes, Mechanism of Transcription and process of translation. Restriction endonucleases, ligases, linker , prokaryotic and eukaryotic cloning vectors , Introduction of DNA fragments in to vectors , r-DNA technology , Gel Electrophoresis, Blotting techniques and their applications, Bacterial recombination.	**10 lectures**
Unit –II	**Plant Biotechnology** Tissue culture laboratory requirements, techniques, Tissue culture methods, Protoplast fusion, germ plasm conservation, transgenic organisms., Brief idea about application of plant biotechnology	**10 lectures**
Unit –III	**Environmental Biotechnology** Basic concept and issue of environment, A brief idea of air, water pollution and it's control through biotechnology, Green house effect, Acid rain, Ozone depletion and their impact on the environment.	**10lectures**
Unit-IV	**Ethics in Biotechnology** Ethical problems involved in medical and agricultural bio-technology, IPP, IPR, Patenting rules with examples	**10 lectures**

Internal Assessment: Home Assignment submission

SECOND SEMESTER

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC -I)

F. M. 100 (80+20) (04 credits)

ENVIRONMENTAL STUDIES

Unit –I	**Basic concepts of Environmental studies**: The Environment - Air, Water and Land, Environmental factors (Abiotic factors : Light , Temp ,Soil ,Water, Air and Biotic factors) ,Ecological adaptations .Ecological succession (hydrosere and xerosere)	**10 lectures**
Unit –II	**Ecosystem** : Structure and Function ,Energy flow , Food chain , Food web , Ecological Pyramids , Bio-geo –chemical cycles: Hydrological cycle (water) ,Gaseous cycles (Oxygen and Carbon dioxide) Sedimentary cycle (Nitrogen and Sulphur) Population studies: population density,natality,mortality,carrying capacity and growth curves.	**10 lectures**
Unit –III	**Environmental pollution** : Air pollution, Water pollution ,Soil pollution ,Noise pollution, radiation pollution . Depletion of Ozone layer , Green house effects ,Pollution indicators(lichen and algal species)	**10 lectures**
Unit-IV	Renewable and Non-renewable energy resources. Conservation of natural recourses .Forest Conservation and afforestation, Social Forestry, Biodiversity conservation,(*in situ* and *ex situ)* . Pollution control Board and its functions, Environmental awareness .	**10 lectures**

Internal Assessment: written Examination

FIRST SEMESTER: MINOR-1 GE-I (Botany)

F.M 80+20=100(04 credits) Duration of Exams: 3 hours

Minor –I Generic Elective-1 (Bio-molecules and Biodiversity in life)

Unit-1: Cell and Molecular Biology

Structure of a typical plant cell, Structure and function of cell wall, cell membrane, mitochondria, chloroplast, endoplasmic reticulum, golgibodies, lysosomes, peroxisomes, glyoxysomes, ribosomes, cytoskeletons, nucleus, chromosomes, Process of cell division, Structure and function of nucleic acid., DNA Replication, Concept of Gene, Lac Operon

Unit-II : Microbiology& Genetics

Viruses, Historical account, occurrence, morphology and structure of TMV and bacterial (T4) viruses, replication of bacteriophages, viroids, prions. Eubacteria: Structure, endospore formation, nutrition, recombination, economic importance, Cyanobacteria, Archebacteria, Economic importance of microbes, Principles of inheritance- Mendel's experiment, gene interactions, Cytoplasmic inheritance, gene mutation: spontaneous and induced mutation. Chromosomal aberrations, , Polyploidy, Plant breeding- general account

Unit-III : Algae, Fungi and Pathology

Thallus organization, reproduction and economic importance of algae. Characteristics and life cycle of the following genera: *Chlamydomonas, Oedogonium, Zygnema, Chara, Vaucheria, Fucus, Batrachospermum, Polysiphonia*.

General characteristics of fungi: Characteristics and life cycle of the following genera: *Phytopthora, Rhizopus, Saccharomyces, Penicillium, Erysiphe, Puccinia, Agaricus.* Symptoms, causative organism, transmission and control measures of the following diseases- Tobacco mosaic diseases, Wilt of potato, Damping off, late blight, white rust, Powdery mildew, rust.

Unit-IV : Diversities in Land Plants

General features of Bryophytes, structure, reproduction and life cycle of *Riccia, Marchantia, Anthoceros, Sphagnum.* General features of Pteridophytes, morphology, anatomy, reproduction and life cycle of *Psilotum, Lycopodium, Selaginella, Equisetum, Marsilea.* General features of Gymnosperm, morphology, anatomy, reproduction and life cycle of *Cycas, Pinus* and *Gnetum.*

Unit-V : Angiosperm Anatomy and Embryology

Tissues: Meristematic tissues, its organization in the shoot and root apices, mechanical tissue types, principles involved in their distribution, anomalous secondary growth, root stem transition. Microsporogenesis, megasporogenesis, development of male and female gametophyte, double fertilization, structure and development of endosperms, development of dicot and monocot embryo.

THIRD SEMESTER: MINOR-1 GE-III F.M 80+20=100 (04 credits)

Minor –1 Generic Elective-III (Plant and Human Welfare, Plant physiology & Biostatistics)

Unit-I : Angiosperm Systematics and Economic Botany:

Taxonomic hierarchy: Taxonomic category, taxonomic groups, Principles and rules; type method; principle of priority; Artificial, natural and phylogenetic system of classification, modern taxonomy in relation to anatomy, embryology, palynology, cytology ,Economic uses of the following plants in relation to human welfare (in form of short notes) with reference to rice, wheat, maize, Bengal gram, green gram, black gram, mustard, groundnut, sunflower, cotton, jute, coir, coffee, tea, Rauwolfia, Cinchona, Ocimum, Mentha, Aegle.

Unit – II : Plant Physiology

Water potential, Diffusion, Osmosis, Absorption of water Ascent of sap, Transpiration , Absorption of minerals ,Translocation of organic solutes Photosynthesis : Light & Dark reaction ,Mechanism of photophosphorylation; Path of carbon , C_3, C_4 and CAM cycle , Respiration; glycolysis ,anaerobic path way TCA cycle ,electron transport system , Mechanism of oxidative phosphorylation ,hexose monophosphate shunt, Nitrogen fixation: symbiotic and non-symbiotic mechanism, , phases of growth, Phytohormones: discovery, physiological role and mechanism of action of Auxins, Gibberellins and cytokinins.Flowering: Photoperiodism and vernalization.

Unit:III Molecular Biology: DNA as a genetic material, DNA replication, central dogma, transcription and translation , Gene concept,r-DNA technology.

Unit-IV : Environmental Biology

Environment- soil, water, air, biotic components- general account Communities and their characteristics. Ecosystems: Concepts, structure and function of ecosystem, energy flow, bio-geo chemical cycle. Renewable and non-renewable energy an d its management. Conservation of Bio-diversity, pollution of air, water, soil, noise, thermal and radioactive and it's control and prevention. Global warming, Acid rain and Ozone depletion

Unit-V : Biostatistics

Need of statistics in biology, collection of biological data, frequency distribution, frequency, relative frequency and cumulative frequency, central tendency- mean, median, mode and their biological significance, dispersion, range, Quartile deviation, mean deviation, varience, standard deviation and their biological importance, Estimation and hypothesis testing, student's t –test and Chi-square test . their application

FOURTH SEMESTER: SEC-II F.M 80+20=100(04 credits)

Subject Specific Skill (SEC-II) : Applied Biotechnology

Unit-I: Genetic Engineering

Structure and Biological importance of DNA and RNA , DNA replication in prokaryotes, Mechanism of Transcription and process of translation.

Restriction endonucleases, ligases, linker , prokaryotic and eukaryotic cloning vectors , Introduction of DNA fragments in to vectors , r-DNA technology , Gel Electrophoresis, Blotting techniques and their applications, Bacterial recombination.

Unit-II : Plant Biotechnology

Tissue culture laboratory requirements, techniques, Tissue culture methods, Protoplast fusion, germ plasm conservation, transgenic organisms., Brief idea about application of plant biotechnology

Unit –III: Animal Biotechnology

Primary and established cell culture, culture media, basic techniques of mammalians cell culture, Application of animal cell culture, Individual concept of immune system, Brief idea about Antigen-Antibody interaction

Unit –IV: Environmental Biotechnology

Basic concept and issue of environment, A brief idea of air, water pollution and it's control through biotechnology, Green house effect, Acid rain, Ozone depletion and their impact on the environment.

Unit –V: Ethics in Biotechnology

Ethical problems involved in medical and agricultural bio-technology, IPP, IPR, Patenting rules with examples

Internal Assessment: Home Assignment submission

SECOND SEMESTER

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC -1)

F. M. 50 (40+10) (02 credits)

ENVIRONMENTAL STUDIES

UNIT –I

Basic concepts Environmental studies: Definitions: The Environment - Air, Water and Land. Ecology ,Ecosystem , Environmental factors (Abiotic factors : Light , Temp ,Soil ,Water, Air and Biotic factors) ,Ecological adaptations .

UNIT –II

Ecosystem : Structure and Function ,Energy flow , Food chain , Food web , Ecological Pyramids , Bio-geo –chemical cycles: Hydrological cycle (water) ,Gaseous cycles (Oxygen and Carbon dioxide) Sedimentary cycle (Nitrogen and Sulphur)

UNIT –III

Population Studies: Population density , Natality ,mortality ,carrying capacity ,age , Population growth curves ,community structure ,Ecological Succession (Hydrosere and Xerosere)

UNIT –IV

Environmental pollution : Air pollution, Water pollution ,Terrestrial pollution ,Noise pollution, radiation pollution .Types of pollutants , Depletion of Ozone layer , Green house effects ,Smog ,Acid rain

Unit-V

Renewable and Non-renewable resources and their Conservation, Conservation of natural recourses , Soil erosion and conservation. Forest Conservation. Afforestation, Social Forestry, Biodiversity conservation, Pollution control Board and functions, Environmental awareness and mass education

Internal Assessment: written Examination

Discipline Specific Elective Courses (DSE)

Semester-V

Discipline Specific Elective (DSE –1):Analytical Techniques in Plant Sciences – 100 marks (Credits-6: Theory-4, Practical-2)THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit –I	**Imaging and related techniques:** Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching	**10 lectures**
Unit-II	**Cell fractionation:** Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.	**5 lectures**
Unit-III	**Radioisotopes:** Use in biological research, auto-radiography, pulse chase experiment.	**3 lectures**
	Spectrophotometry: Principle and its application in biological research.	**3 lectures**
	Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.	**6 lectures**
Unit-IV	**Characterization of proteins and nucleic acids:** Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE	**5 lectures**
Unit-V	**Biostatistics:** Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit	**5 lectures**

Practical (20 classes, each class of 2h)

Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.

2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).
12. Estimation of plant pigments.

Suggested Readings

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

Semester-V

Discipline Specific Elective (DSE –2):Natural Resource Management – 100 marks (Credits-6: Theory-4, Practical-2)THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit –I	Natural resources: Definition and types. Sustainable utilization : Concept, approaches (economic, ecological and socio-cultural).	**5 lectures**
Unit –II	Land: Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.	**5 lectures**
	Water: Fresh water (rivers, lakes, groundwater, aquifers, watershed);Marine; Estuarine; Wetlands; Threats and management strategies	**4 lectures**
Unit –III	Biological Resources: Biodiversity-definition and types; Significance;Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).	**8 lectures**
	Forests: Definition, Cover and its significance (with special reference toIndia); Major and minor forest products; Depletion; Management.	**4 lectures**
Unit –IV	Energy: Renewable and non-renewable sources of energy Contemporary practices in resource management: EIA, GIS,Participatory Resource Appraisal, Ecological Footprint with emphasis oncarbon footprint.	**6 lectures**
Unit –V	Resource Accounting; Waste management. National and international efforts in resource management and conservation	**4 lectures**

Practical (20 classes, each class of 2h)
Practical
1. Estimation of solid waste generated by a domestic system (biodegradable andNon biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. 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.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice
Hall of India Private Limited, New Delhi.

SEMESTER-VI

Discipline Specific Elective (DSE –3): Biostatstics – 100 marks(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit –I	Biostatistics - definition - statistical methods - basic principles. Variables -measurements, functions, limitations and uses of statistics.	**8 lectures**
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.	**8 lectures**
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.	**10 lectures**
Unit –IV	Correlation - types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression	**8 lectures**
Unit –V	Statistical inference - hypothesis - simple hypothesis - student 't' test - chisquare test.	**6 lectures**

Practical (20 classes, each class of 2h)

Practical

1) Calculation of mean, standard deviation and standard error
2) Calculation of correlation coefficient values and finding out the probability
3) 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 Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press, UK

SEMESTER-VI

Discipline Specific Elective (DSE –4):Stress Biology – 100 marks(Credits-6: Theory-4, Practical-2)THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit –I	**Defining plant stress:** Acclimation and adaptation.	**2 lectures**
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.	**12 lectures**
Unit –III	**Stress sensing mechanisms in plants:** Role of nitric oxide. Calcium modulation, Phospholipid signaling	**12 lectures**
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.	**10 lectures**
Unit –V	**Reactive oxygen species–Production and scavenging mechanisms**.	**4 lectures**

Practical (20 classes, each class of 2h)

Practical

1. Quantitative estimation of peroxidase activity in the seedlings in the absence andpresence of salt stress.
2. Superoxide activity in seedlings in the absence and presence of salt stress.
3. Assay of Ascorbate
4. Assay of peroxidase.
5. Assay of superoxide dismutase activity.
6. Quantitative estimation and analysis of catalase.

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. SinauerAssociates Inc. USA. 6th edition.

SEMESTER-I BOTANY CORE

Core Course I: Microbiology and Phycology 100 marks (Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

UNIT –I	Introduction to microbial world, microbial nutrition, growth and metabolism	**2 lectures**
	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	**5 lectures**
UNIT - II	**Bacteria: -** Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).	**5 lectures**
UNIT– III	**Algae:-** General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry. Economic importance of algae.	**6 lectures**
UNIT- IV	**Cyanophyta:-** Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction. economic importance; role in biotechnology. Morphology and life-cycle of *Nostoc*	**5 lectures**
	Chlorophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of*Chlamydomonas, Volvox, Oedogonium, Coleochaete.*	**5 lectures**
UNIT - V	**Charophyta:-** General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara;* evolutionary significance.	**2 lectures**
	Xanthophyta:- General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of *Vaucheria*	**3 lectures**
	Phaeophyta:- Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles	**3 lectures**
	Rhodophyta:- General characteristics, occurrence, range of thallus	**4 lectures**

	organization, cell structure and reproduction. Morphology and life-cycle of*Polysiphonia.*	

BOTANY CORE

PRACTICAL (20 CLASSES 2 HOURS EACH)

MICROBIOLOGY	1. Electron micrographs/Models of viruses - T-Phage and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle. 2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule. 3. Gram staining. 4.Endospore staining (endospores takenfrom soil bacteria)
PHYCOLOGY	Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* ,Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, 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-I BOTANY CORE

Core Course II: Biomolecules and Cell Biology-100 marks(Credits-6:Theory-4,Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes

UNIT -I	**Biomolecules:-** Types and significance of chemical bonds; Structure and properties of water; pH and buffers.	**2 lectures**
	Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols - mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage -starch, insulin)	**3 lectures**
	Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties	**2 lectures**
	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	**2 lectures**
	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, its role as a energy currency molecule.	**3 lectures**
	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.	**4 lectures**
UNIT-III	**The cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).	**2 lectures**
	Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport - Passive, active and facilitated transport, endo cytosis and exocyosis.	**3lectures**
UNIT-IV	**Cell organelles: Nucleus;** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.	**3 lectures**
	Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament **Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.	**2 lectures**
	Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	**2 lectures**

UNIT -V	**Cell division:** Eukaryotic cell cycle, different stages of mitosis and meiosis. Cell cycle, Regulation of cell cycle.	**6 lectures**

BOTANY CORE

PRACTICALS(20 CLASES OF 2 hours duration)

PRACTICALS	1.Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins 2.Study of plant cell structure with the help of epidermal peel mount o *Onion/Rhoeo/Crinum*.f 3.Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf. 4.Measurement of cell size by the technique of micrometry. 5.Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains) 6.Study of cell and its organelles with the help of electron micrographs. 7.Study the phenomenon of plasmolysis and deplasmolysis. 8.Study different stages of mitosis and meiosis using aceto carmine and aceto orcine methods

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. Freemanand 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 Fra

SEMESTER-II BOTANY CORE

Core Course III: Mycology and Phytopathology – 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction to true fungi:** Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification. **Chytridiomycetes:** General account	**5 lectures**
	Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus.*	**4 lectures**
	Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Aspergillus, Penicillium, Alternaria* and *Neurospora,.*	**5 lectures**
Unit-II	**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;*.	**5 lectures**
	Allied Fungi: General characterises; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.	**3 lectures**
	Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.*	**4 lectures**
Unit-III	**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.	**4 lectures**
Unit-IV	**Applied Mycology:** Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological	**5 Lectures**

	control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.	
Unit-V	**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 disease of Cotton.Viral diseases - Tobacco Mosaic viruses, vein clearing. Fungal diseases - Early blight of potato, Black stem rust of wheat, white rust of crucifers	**5 lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2HOURS)

PRACTICALS	1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps &basidiocarps). 2. *Rhizopus:* study of asexual stage from temporary mounts and sexual structures through permanent slides. 3. *Aspergillus* and *Penicillium:* study of asexual stage from temporary mounts. Study ofSexual stage from permanent slides/photographs *4.Alternaria:* Specimens/photographs and temporary mounts. 5.*Puccinia:* Herbarium specimens of Black Stem Rust of Wheat and infectedBarberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts. 6.*Agaricus:* Specimens of button stage and full grown mushroom; sectioning of gills of*Agaricus,* fairy rings and bioluminescent mushrooms to be shown. 7.*Albugo:* Study of symptoms of plants infected with *Albugo;* asexual phase study through section/ temporary mounts and sexual structures through permanent slides. 8. 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 endo mycorrhiza (Photographs)

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. 3rdedition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers IndiaLtd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, Indi

SEMESTER-II BOTANY CORE

Core Course IV: Archegoniate - 100 marks (Credits-6 Theory-4, Practical 2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory +20 Practical classes]

Unit-I	**Introduction:** Unifying features of archegoniates; Transition to land habit; Alternation of generations. Types of life cycles, Sporophytic generation, gametophytic generation.	**2 lectures**
Unit-II	**Bryophytes:** General characteristics; Adaptations to land habit; Classification; Range of thallus organization.Classification (up to family).*Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria;* Reproduction and evolutionary trends in Riccia, Marchantia , Anthoceros and Funaria (developmental stages not included). Ecological and economic importance of bryophytes.	**12 lectures**
Unit-III	**Pteridophytes:** General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *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.	**10 lectures**

Unit-IV	**Gymnosperms:** General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo* and *Gnetum.* (Developmental details not to be included). Ecological and economic importance.	**8 lectures)**
Unit-V	**Fossils:** Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia, Calamites, Lepidodendron, Lyginopteris* and *Cycadeoidea.*	**8 lectures**

PRACTICAL(20CLASSES OF 2 HOURS duration) **BOTANY CORE**

PRACTICAL	***Riccia*** - Morphology of thallus. ***Marchantia-*** Morphology of thallus, whole mount of Gemmae (all temporary slides), longitudinal section of Sporophyte (all permanent slides). ***Anthoceros-*** Morphology of thallus, dissection of sporophyte (temporary slide), vertical section of thallus (permanent slide). ***Pellia, Porella-*** Permanent slides. ***Sphagnum-*** Morphology of plant, whole mount of leaf (permanent slide only). ***Funaria-*** Morphology, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, and protonema. .***Psilotum-*** Study of specimen, transverse section of synangium (permanent slide). ***Selaginella-*** Morphology, whole mount of leaf with ligule, transverse section of stem, longitudinal section of strobilus (permanent slide . ***Equisetum-*** Morphology, transverse section of internode, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slides) ***Pteris-*** Morphology, transverse section of rachis, transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).

	Cycas- Morphology (coralloid roots, bulbil, leaf), transverse section of coralloid root, transverse section of rachis, longitudinal section of ovule, transverse section of root (permanent slide). ***Pinus-*** Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stemlongitudinal 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) 14.**Botanical excursion.**

Suggested Readings

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

SEMESTER-III **BOTANY CORE**

Core Course V: Anatomy of Angiosperms - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours) [75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction and scope of Plant Anatomy:** Applications in systematics, forensics and pharmacognosy.	**2 lectures**
	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.	**5 Lectures**
Unit-II	**Stem:** 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.	**5 Lectures**
	Leaf: Structure of dicot and monocot leaf, Kranz anatomy.	**4 lectures**
	Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescentcentre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.	**4 Lectures**
Unit-III	**Vascular Cambium:** Structure, function and seasonal activity of cambium; Secondary growth in root and stem.	**4 Lectures**
	Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.	**5 Lectures**
	Periderm: Development and composition of periderm, rhytidome and lenticels.	**3 Lectures**
Unit -IV	**Adaptive and Protective Systems** Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification);Anatomical adaptations of xerophytes and hydrophytes.	**5 Lectures**
UNIT-V	**Secretory System:** Hydathodes, cavities, lithocysts and laticifers.	**3 Lectures**

PRACTICALS (20CLASSES OF 2 HOURS duration)

PRACTICALS	1. Study of anatomical details through permanent slides/temporary stainmounts/macerations/ museum specimens with the help of suitable examples. 2. Apical meristem of root, shoot and vascular cambium. 3. Distribution and types of parenchyma, collenchyma and sclerenchyma. 4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates;xylem fibres. 5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood. 6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres. 7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular. 8. Root: monocot, dicot, secondary growth. 9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. 10.Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). 11.Adaptive Anatomy: xerophytes, hydrophytes. 12.Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA
4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

SEMESTER-III BOTANY CORE

Core Course VI: Economic Botany - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

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 diversty.	**3 lectures**
Unit-II	**Cereals :** Wheat and Rice (origin, morphology, processing & uses), brief account of millets.	**3 lectures**
	Legumes: General account, importance to man and ecosystem.	**3 lectures**
	Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato - morphology, propagation & uses.	**3 lectures**
Unit-III	**Spices:** Listing of important spices, their family and part used, economic importance with specialreference to fennel, saffron, clove and black pepper	**4 lectures**
	Beverages: Tea, Coffee (morphology, processing &uses)	**4 lectures**
	Drug-yielding plants: Therapeutic and habit-forming drugs with specialreference to *Cinchona, Digitalis, Papaver andCannabis.*	**4 lectures**
	Tobacco: Tobacco (Morphology, processing, uses and health hazards)	**2 lectures**
Unit-IV	**Oils & Fats:** General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* and Coconut (Botanical name, family & uses)	**4 lectures**
	Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.	**4 lectures**
Unit-V	**Natural Rubber:** Para-rubber: tapping, processing and uses.	**2 lectures**
	Timber plants: General account with special reference to teak and pine.	**2 Lectures**
	Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).	**2 lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2 HOURS DURATION)

PRACTICALS	**1. Cereals:** Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).

	2. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests). **3. Sugars & Starches:** Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests). **4. Spices:** Black pepper, Fennel and Clove (habit and sections). **5. Beverages:** Tea (plant specimen, tea leaves), Coffee (plant specimen, beans). **6. Oils & Fats:** Coconut- T.S. nut, Mustard-plant specimen, seeds; tests for fats incrushedseeds. **7. Essential oil-yielding plants:** Habit sketch of*Rosa,* V*etiveria, Santalum* and *Eucalyptus*(specimens/photographs). **8. Rubber:** specimen, photograph/model of tapping, samples of rubber products. **9. Drug-yielding plants:** Specimens of *Digitalis, PapaverandCannabis.* **10. Tobacco:** specimen and products of Tobacco. **11. Woods:** Tectona, Pinus: Specimen, Section of young stem. **12. Fibre-yielding plants:** Cotton (specimen, whole mount of seed to show lint andfuzz;whole mount of fibre and test for cellulose), Jute (specimen, transverse sectionof stem, test for lignin on transverse section of stem and fibre).

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. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publisher

SEMESTER-III BOTANY CORE

Core Course VII: Genetics - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Mendelian genetics and its extension** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.	**16 lectures**
Unit-II	**Extrachromosomal Inheritance:** Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast;Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*	**6 lectures**
Unit-III	**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; Numericals based on gene mapping; Sex Linkage.	**12 lectures**
Unit-IV	**Variation in chromosome number and structure:** Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy	**8 lectures**
	Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens - physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation.DNA repair mechanisms.	**6 lectures**
Unit-V	**Fine structure of gene:** Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.	**6 lectures**
	Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.	**6 lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2 HOURS DURATION)

PRACTICALS	1. Meiosis through temporary squash preparation. 2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis. 3. Chromosome mapping using test cross data. 4. Pedigree analysis for dominant and recessive autosomal and sex linked traits with floral chart. 5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4). 6. Blood Typing: ABO groups & Rh factor.

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. 5thedition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings,
U.S.A. 10th 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 BOTANY CORE

Core Course VIII: Molecular Biology - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

UNIT-I	**Nucleic acids : Carriers of genetic information:** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.	**4 lectures**
UNIT-II	**The Structures of DNA and RNA / Genetic Material:** DNA	**8 lectures**

	Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA-Prokaryotes, Viruses, Eukaryotes. RNA Structure- Organelle DNA -mitochondria and chloroplast DNA.The Nucleosome -Chromatin structure-Euchromatin, Heterochromatin-Constitutive and Facultative heterochromatin.	
	The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles - bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, 9 (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.	**6 lectures**
UNIT-III	**Central dogma and genetic code:** Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of M rna template), Genetic code (deciphering & salient features)	**2 lectures**
	Mechanism of Transcription: Transcription in prokaryotes; Transcription in eukaryotes.	**4 lectures**
	Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes, exon shuffling.	**5 lectures**
UNIT-IV	**Translation (Prokaryotes and eukaryotes):** 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.	**6 lectures**
UNIT-V	**Regulation of transcription in prokaryotes and eukaryotes:** Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli.* Eukaryotes: transcription factors.	**5 lectures**

PRACTICALS (20 CLASSES OF 2 HOURS EACH)

PRACTICALS	1. Preparation of LB medium and raising *E.Coli.* 2. RNA estimation by orcinol method. 3. DNA estimation by diphenylamine reagent/UV Spectrophotometry. 5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication). 6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs. 7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) 8.Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

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

Core Course IX: Plant Ecology and Phytogeography - 100 marks (Credits-6: Theory-4, Practical-2) Theory (each class 1 hour) PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction** Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environmental, concept of hydrosphere and lithosphere and dynamism, homeostasis.	**2 lectures**
Unit-II	**Soil:** Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.	**5 lectures**
	Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.	**2 lectures**
	Light, temperature, wind and fire: Variations; adaptations of plants to their variation.	**4 lectures**
Unit-III	**Population ecology:** Characteristics and Dynamics .Ecological Speciation	**4 lectures**
	Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession - processes, types; climax concepts.	**4 lectures**
Unit-IV	**Ecosystems:** Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.	**4 lectures**
	Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.	**5 lectures**
Unit-V	**Phytogeography:** Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India;	**7 lectures**

	Local Vegetation.	

BOTANY CORE

PRACTICALS (20 CLASSES OF 2 HOURS EACH)

PRACTICALS	1. Determination of pH of various soil and water samples (pH meter,universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats. 4. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 5(a). Study of morphological adaptations of hydrophytes and xerophytes (four each). (b). Study of biotic interactions of the following: Stem parasite *(Cuscuta),* Root parasite*(Orobanche)* Epiphytes, Predation (Insectivorous plants). 6.Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed). 7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 8.Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 9. Field visit to familiarize 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.

3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford

University Press. U.S.A.

5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

SEMESTER-IV BOTANY CORE

Core Course X: Plant Systematics – 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant identification, Classification, Nomenclature; Biosystematics**	**2 lectures**
	Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access	**5 lectures**
Unit-II	**Taxonomic hierarchy:** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).	**5 lectures**
	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	**5 lectures**
Unit-III	**Systematics- an interdisciplinary science:** Evidence from palynology, cytology, phytochemistry and molecular data.	**6 lectures**
	Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm	**6 lectures**
Unit-IV	**Biometrics, numerical taxonomy and cladistics:** Characters; Variations; OTUs, character weighting and coding; cluster analysis; Phenograms, cladograms (definitions and differences).	**4 lectures**
Unit-V	**Phylogeny of Angiosperms:** Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly,	**7 lectures**

	Paraphyly, polyphyly and clades).origin& evolution of angiosperms; coevolutionof angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	

BOTANY CORE

Practical (20 classes, each class of 2h)

Practical	1. 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* 2. Field visit (local) – Subject to grant of funds from the university. 3. 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, G. (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 BOTANY CORE

Core Course XI:Reproductive Biology of Angiosperms-100 marks(Credits-6:Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks(Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

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.	**2 lectures**
Unit-II	**Anther:** Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.	**2 lectures**
	Pollen biology: Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.	**5 lectures**
Unit-III	**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.	**5 lectures**
	Endosperm: Types, development, structure and functions.	**3 lectures**
	Embryo: Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo;Unusual features; Embryo development in *Paeonia.*	**6 lectures**
Unit-IV	**Pollination and fertilization:** Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.	**4 lectures**
	Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility: mixed pollination, bud pollination,	**7 lectures**
Unit-V	**Seed:** Structure, importance and dispersal mechanisms	**3 lectures**
	Polyembryony and apomixes: Introduction; Classification; Causes and applications.	**4 lectures**
	Germline transformation: Pollen grain and ovules through pollen tube pathway method.	**2 lectures**

BOTANY CORE

Practical (20 classes, each class of 2h)

Practical	1. 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. 2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Calculation of germination in different media using hanging drop method. 3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). 4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus. 5. Intra-ovarian pollination; Test tube pollination through photographs. 6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria. 7. 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, Netherland

SEMESTER-V BOTANY CORE

Core Course XII: Plant Physiology - 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours

[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant water relationship**: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap-cohesion-tension theory. Transpiration and factors affecting transpiration, anti transpirants, mechanism of stomatal movement.	**6 lectures**
	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.	**5 lectures**
Unit-II	**Mineral nutrition:** Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.	**5 lectures**
Unit-III	**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.	**5 lectures**
Unit-IV	**Plant growth regulators:** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene.	**10 lectures**
Unit-V	**Physiology of flowering:** Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.	**4 lectures**
	Phytochrome: Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.	**5 lectures**

BOTANY CORE

Practical (20 classes, each class of 2h)

Practical	1. Determination of osmotic potential of plant cell sap by plasmolytic method. 2. Determination of water potential of given tissue (potato tuber) by weight method. 3. Study of the effect of light on the rate of transpiration in excised twig/leaf. 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. 5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces). 6. To study the phenomenon of seed germination (effect of light). 7. To study the induction of amylase activity in germinating barley grains. **Demonstration experiments** 1. To demonstrate suction due to transpiration. 2. Fruit ripening/Rooting from cuttings (Demonstration). Bolting experiment/*Avena* coleptile bioassay (demonstration)

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., M0ller, 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 BOTANY CORE

Core Course XIII: Plant Metabolism - 100 marks (Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)[
75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Concept of metabolism:** Introduction, anabolic and catabolic pathways,regulation of metabolism, role of regulatory enzymes (allosteric and Isozymes).	**5 lectures**
	Carbohydrate metabolism: Synthesis and catabolism of starch.	**1 lectures**

Unit-II	**Carbon assimilation:** Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory 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 CO_2 reduction.	**10 lectures**
Unit-III	**Carbon Oxidation:** Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, , mitochondrial electron transport, oxidative phosphorylation, factors affecting respiration.	**6 lectures**
	ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase,	**4 lectures**
Unit-IV	**Lipid metabolism:** Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α- oxidation.	**5 lectures**
Unit-V	**Nitrogen metabolism:** Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.	**5 lectures**

BOTANY CORE

Practical (20 classes, each class of 2h)

Practical	1. Chemical separation of photosynthetic pigments. 2. Experimental demonstration of Hill's reaction. 3. To study the effect of light intensity on the rate of photosynthesis. 4. Effect of carbon dioxide on the rate of photosynthesis. 5. To compare the rate of respiration in different parts of a plant.. 6. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination. 7.Demonstration of fluorescence by isolated chlorophyll pigments. 8. 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., M0ller, I.M. and Murphy, A (2015). Plant Physiology and Development. SinauerAssociates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

SEMESTER-VI BOTANY CORE

Core Course XIV: Plant Biotechnology - 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15+ End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant Tissue Culture:** Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones).	**3 lectures**
Unit-II	Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).	**7 lectures**
Unit-III	**Recombinant DNA technology-I:** Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector;Eukaryotic Vectors (YAC) Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).	**10 lectures**
Unit-IV	**Recombinant DNA technology-II:** Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain geneof interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; 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).	**10 lectures**
Unit-V	**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); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products-Human Growth Hormone; Humulin; Biosafety concerns.	**10 lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2 HOURS EACH)

PRACTICALS	1. (a) Preparation of MS medium. (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura, Brassica* etc. 2.Study of anther, embryo and endosperm culture, micro propagation, somatic Embryogenesis & artificial seeds through photographs. 3. Construction of restriction map of circular and linear DNA from the data provided. 4. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 5. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savrtomato through photographs. 6.Restriction digestion and gel electrophoresis of plasmid DNA.(Demonstration)

SUGGESTED READINGS

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications Of recombinant DNA. ASM Press, Washington.
4. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication HousePvt. Ltd., New Delhi. 5th edition.
5. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5thedition.
6. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
7. Chawla, H.S. (2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co.Pvt Ltd., New Delhi.
7. Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi

KHALLIKOTE UNIVERSITY,

BERHAMPUR-760001, ODISHA

SYLLABUS

U.G. (Botany)

2017

P.G.DEPARTMENT OF BOTANY

KHALLIKOTE AUTONOMOUS COLLEGE,

BERHAMPUR-760001, ODISHA

COURSE STRUCUTRE FOR UG SCIENCE UNDER CBCS

SEM	Core course (14) A	AECC(2) Compulsory B	AECC(2) Skill Based C	DSE(4) D	GE(4) E	Credits	Marks
I S	CORE-1	MIL (O/H/T/E)			GE-1 Minor-1	20	350
	CORE-2						
II S	CORE-3	EVS			GE-2 Minor-2	20	350
	CORE-4						
III S	CORE-5		SEC-I Communicative English and writing Skill (Comp.)		GE-3 Minor-1	26	450
	CORE-6						
	CORE-7						
IV S	CORE-8		SEC-II Subject Specific Skill		GE-4 Minor-2	26	450
	CORE-9						
	CORE-10						
V S	CORE-11			DSE-1 DSE-2		24	400
	CORE-12						
VI S	CORE-13			DSE-3 DSE-4		24	400
	CORE-14						
TOTAL	84Credits/ 1400 marks	04 credits 100 marks	04 credits 100marks	24 credits 400marks	24credits 400marks	140	2400

FOR SCIENCE COURSES

A. Core course =Hons 14 papers 100x14 =1400 marks (56 credits)

B. **AECC** (Ability Enhancement Compulsory Course)= MIL (O/H/T/E) AND EVS

C. **SEC-1 :** to be taught by English Department and **SEC-II** will be Adv.Biotech/Adv.Chem/Applied Phys/ Modern Math and not same as Core subject. Syllabus for SEC-II is to be prepared by Deptt./BOS for 50marks(40+10 marks) with four units, Exams. Will be for 2 hours duration.

D. **DSE 1 to 4 :** Spl. Hons, Papers to be selected from syllabus given by Utkal Univ. DSE-4 can be Research methodology/Theory/Practical/projects/field tour as decided by Deptt./BOS

E. **GE-1 to 4** (two subjects, Minor-1&Minor-2)

Choose any two from Bot /Chem /Phys/Math/Zool. Expect Core Subject

Try to change the title of the course by keeping course content same .

Practicals in SemesterI, II , V and VI can be combined into one practical of 50 marks and 6 hr duration. For Semester III and IV ,there can be one practical of 75 marks and 6hr duration.

DETAILED COURSE STRUCTURE FOR SCIENCE (BOTANY) underCBCS, 2017-18

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS	MARKS
FIRST SEMESTER	Ability Enhancement Course-I	MIL (O/H/T/E)	02	50
	CORE-1 Theory	Microbiology and phycology	04	75
	CORE-2 Theory	Biomolecules and Cell Biology	04	75
	PRACTICAL FOR CORE -1 AND CORE-2	Microbiology and phycology Biomolecules and Cell Biology	04	50
	Generic Elective-I Theory **Practical**	Molecular Biology and Biodiversity of life	04+02	75+25
FIRST SEMESTER		**TOTAL**	**20 credits**	**350 marks**
SECOND SEMESTER	Ability Enhancement Course-II	EVS	04	100
	CORE-3 Theory	Mycology & Phytopathology	04	75
	CORE-4 Theory	Archegoniate	04	75
	PRACTICAL FOR CORE -3 AND CORE-4	Mycology & Phytopathology Archegoniate	04	50
	Generic Elective-II Theory **Practical**	Diversities in Land Plants	04+02	75+25
SECOND SEMESTER		**TOTAL**	**22 credits**	**400 marks**
THIRD SEMESTER	CORE-5 Theory	Anatomy of angiosperm	04	75
	CORE-6 Theory	Economic Botany	04	75
	CORE-7 Theory	Genetics	04	75
	PRACTICAL FOR CORE -5, CORE-6 AND CORE-7		06	75
	SEC-I	Communicative English & writing Skill	04	100
	Generic Elective-III Theory **Practical**	Plant and human Welfare, Basic Biotechnology	04+02	75+25
THIRD SEMESTER		**TOTAL**	**28 credits**	**500 marks**

IMPORTANT NOTE: About practical examinations

First semester: ONE Practical for CORE-1 and CORE-2 =50 marks (6 hr)

Second semester: ONE Practical for CORE-3 and CORE-4 =50 marks (6 hr)

Third semester: ONE Practical for CORE-5, CORE-6 and CORE-7 =75 marks (6 hr)

Fourth semester:ONE Practical for CORE-8, CORE_9 and CORE-10 =75 marks (6 hr)

Fifth semester: ONE Practical for CORE-11 and CORE-12 =50 marks (6 hr)

Sixth Semester: ONE Practical for CORE-13 and CORE-14 =50 marks (6 hr)

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS	MARKS
FOURTH SEMESTER	CORE-8 Theory	Molecular Biology	04	75
	CORE-9 Theory	Ecology	04	75
	CORE-10 Theory	Plant Systematics	04	75
	PRACTICAL FOR CORE -8, CORE-9 AND CORE-10		06	75
	SEC-II	Applied Biotechnology	04	100
	Generic Elective-IV Theory Practical	Zoology - 02	04+02	75
FOURTH SEMESTER		**TOTAL**	**26credits**	**450 marks**
FIFTH SEMESTER	CORE-11 Theory	Reproductive Biology of Angiosperms	04	75
	CORE-12 Theory	Plant Physiology	04	75
	PRACTICAL FOR		04	50

	CORE -11 AND CORE-12			
	DSE-1 Theory Practical	Natural resource management	06	100
	DSE-2 Theory Practical	Biostatistics	06	100
	PRACTICAL FOR DSE -1 AND DSE-2			
FIFTH SEMESTER		**TOTAL**	**24credits**	**400 marks**
SIXTH SEMESTER	CORE-13 Theory Practical	Plant Metabolism	04	75
	CORE-14 Theory Practical	Plant Biotechnology	04	75
	PRACTICAL FOR CORE -13 AND CORE-14		04	50
	DSE-3 Theory Practical	Stress Biology	06	100
	DSE-4 :PROJECTS		06	100
SIXTH SEMESTER		**TOTAL**	**24 credits**	**400 marks**

THEORY-75 marks (60 Term End+15 Internal Assessment)

THEORY-50 marks (40 Term End+10 Internal Assessment)

SEMESTER-I BOTANY CORE

Core Course I: Microbiology and Phycology 100 marks (Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

UNIT –I	**Introduction to microbial world** **Viruses**:-Discovery,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	**7 lectures**
	Bacteria: - Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria	**5 lectures**
UNIT– II	**Algae:-** General characteristics; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, T.V. Desikachary , M.O.P. Iyengar).Economic importance of algae.	**6 lectures**
UNIT- III	**Cyanophyta:-** Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction. Morphology and life-cycle of *Nostoc*	**5 lectures**
	Chlorophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete.*	**5 lectures**
UNIT -IV	**Charophyta:-** General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*.	**2 lectures**
	Xanthophyta:- General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of *Vaucheria*	**3 lectures**
	Phaeophyta:- Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Fucus*	**3 lectures**
	Rhodophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Polysiphonia.*	**4 lectures**

BOTANY CORE

PRACTICAL (20 CLASSES 2 HOURS EACH)

MICROBIOLOGY	1. Electron micrographs/Models of viruses - T-Phage and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle. 2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule. 3. Gram staining. 4.Endospore staining (endospores taken from soil bacteria)
PHYCOLOGY	Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* ,Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, 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, NewDelhi.
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-I BOTANY CORE

Core Course II: Biomolecules and Cell Biology-100 marks(Credits-6:Theory-4,Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes

UNIT -I	**Biomolecules:-** Types and significance of chemical bonds; Structure and properties of water; pH and buffers.	**2 lectures**
	Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols - mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage -starch, insulin)	**3 lectures**
	Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties	**3 lectures**
	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	**3 lectures**
	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	**4 lectures**
UNIT-II	**Bioenergenetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions.ATP: structure, its role as a energy currency molecule.	**3 lectures**
	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.	**4 lectures**
UNIT-III	**Cell and Cell organelle:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).	**2 lectures**
	Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport - Passive, active and facilitated transport, endo cytosis and exocyosis.	**3lectures**
	Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament **Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.	**4 lectures**
	Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	**2 lectures**
UNIT - IV	**Nucleus;** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. **Cell division:** Eukaryotic cell cycle, different stages of mitosis and meiosis. Regulation of cell cycle.	**7 lectures**

BOTANY CORE

PRACTICALS(20 CLASES OF 2 hours duration)

PRACTICALS	1.Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins 2.Study of plant cell structure with the help of epidermal peel mount o *Onion/Rhoeo/Crinum*.f 3.Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf. 4.Measurement of cell size by the technique of micrometry. 5.Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains) 6.Study of cell and its organelles with the help of electron micrographs. 7.Study the phenomenon of plasmolysis and deplasmolysis. 8.Study different stages of mitosis and meiosis using aceto carmine and aceto orcine methods

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. Freemanand 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 Fra

SEMESTER-II BOTANY CORE

<u>Core Course III</u>: Mycology and Phytopathology – 100 marks (Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction to true fungi:** Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification. **Chytridiomycetes:** General account	**5 lectures**
	Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus.*	**2 lectures**
	Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Aspergillus, Penicillium, Alternaria* and *Neurospora,*.	**7 lectures**
Unit-II	**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;*.	**5 lectures**
	Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora.*	**4 lectures**
Unit-III	**Symbiotic associations:** Lichen - General characteristics; range of thallus organization;Types of Lichen Nature of associations of algal and fungal partners; Reproduction.Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.	**5 lectures**
	Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry (Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers).	**5 Lectures**
Unit-IV	**Phytopathology:** Terms and concepts; General symptoms; etiology; symptomology; Host- Pathogen interaction; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases - Citrus canker and angular leaf spot disease of Cotton. Viral diseases - Tobacco Mosaic disease,Vein clearing. Fungal diseases - Black stem rust of wheat, white rust of crucifers	**7 lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2HOURS)

PRACTICALS	1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps &basidiocarps). 2. *Rhizopus:* study of asexual stage from temporary mounts and sexual structures through permanent slides. 3. *Aspergillus* and *Penicillium:* study of asexual stage from temporary mounts. Study ofSexual stage from permanent slides/photographs *4.Alternaria:* Specimens/photographs and temporary mounts. 5.*Puccinia:* Herbarium specimens of Black Stem Rust of Wheat and infectedBarberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts. 6.*Agaricus:* Specimens of button stage and full grown mushroom; sectioning of gills of*Agaricus,* fairy rings and bioluminescent mushrooms to be shown. 7.*Albugo:* Study of symptoms of plants infected with *Albugo;* asexual phase study through section/ temporary mounts and sexual structures through permanent slides. 8. 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 endo mycorrhiza (Photographs)

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. 3rdedition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers IndiaLtd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, Indi

SEMESTER-II BOTANY CORE

Core Course IV: Archegoniate - 100 marks (Credits-6 Theory-4, Practical 2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory +20 Practical classes]

Unit-I	**Introduction:** Unifying features of archegoniates; Transition to land habit; Alternation of generations. Types of life cycles, Sporophytic generation, gametophytic generation.	**2 lectures**
	Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization.Classification (up to family).*Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria;* Reproduction and evolutionary trends in Riccia, Marchantia , Anthoceros and Funaria (developmental stages not included). Ecological and economic importance of bryophytes.	**12 lectures**
Unit-II	**Pteridophytes:** General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *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.	**10 lectures**
Unit-III	**Gymnosperms:** General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo* and *Gnetum.* (Developmental details not to be included). Ecological and economic importance.	**8 lectures)**
Unit-IV	**Fossils:** Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia, Calamites, Lepidodendron, Lyginopteris* and *Cycadeoidea.*	**8 lectures**

PRACTICAL(20CLASSES OF 2 HOURS duration) **BOTANY CORE**

PRACTICAL	***Riccia*** - Morphology of thallus. ***Marchantia-*** Morphology of thallus, whole mount of Gemmae (all temporary slides), longitudinal section of Sporophyte (all permanent slides). ***Anthoceros-*** Morphology of thallus, dissection of sporophyte (temporary slide), vertical section of thallus (permanent slide). ***Pellia, Porella-*** Permanent slides. ***Sphagnum-*** Morphology of plant, whole mount of leaf (permanent slide only). ***Funaria-*** Morphology, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, and protonema. .***Psilotum-*** Study of specimen, transverse section of synangium (permanent slide). ***Selaginella-*** Morphology, whole mount of leaf with ligule, transverse section of stem, longitudinal section of strobilus (permanent slide . ***Equisetum-*** Morphology, transverse section of internode, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slides) ***Pteris-*** Morphology, transverse section of rachis, transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide). ***Cycas-*** Morphology (coralloid roots, bulbil, leaf), transverse section of coralloid root, transverse section of rachis, longitudinal section of ovule, transverse section of root (permanent slide). ***Pinus-*** Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stemlongitudinal 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.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, NewDelhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot.Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

SEMESTER-III BOTANY CORE

Core Course V: Anatomy of Angiosperms - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours) [75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction and scope of Plant Anatomy:** Applications in systematics, forensics and pharmacognosy.	**2 lectures**
	Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements;Pits and plasmodesmata. **Secretory System:** Hydathodes, cavities, lithocysts and laticifers.	**8 Lectures**
Unit-II	**Stem:** Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Types of vascular bundles; Structure of dicot and monocot stem.	**5 Lectures**
	Leaf: Structure of dicot and monocot leaf, Kranz anatomy.	**4 lectures**
	Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescentcentre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.	**4 Lectures**
Unit-III	**Vascular Cambium:** Structure, function and seasonal activity of cambium; Secondary growth in root and stem.	**4 Lectures**
	Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.	**5 Lectures**
	Periderm: Development and composition of periderm, rhytidome and lenticels.	**3 Lectures**
Unit -IV	**Adaptive and Protective Systems** Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification);Anatomical adaptations of xerophytes and hydrophytes.	**5 Lectures**

BOTANY CORE

PRACTICALS (20CLASSES OF 2 HOURS duration)

PRACTICALS	1. Study of anatomical details through permanent slides/temporary stainmounts/macerations/ museum specimens with the help of suitable examples. 2. Apical meristem of root, shoot and vascular cambium. 3. Distribution and types of parenchyma, collenchyma and sclerenchyma. 4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates;xylem fibres. 5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood. 6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres. 7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular. 8. Root: monocot, dicot, secondary growth. 9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. 10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). 11. Adaptive Anatomy: xerophytes, hydrophytes. 12. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA
4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

SEMESTER-III BOTANY CORE

Core Course VI: Economic Botany - 100 marks (Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

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 diversty.	**3 lectures**
	Cereals : Wheat and Rice (origin, morphology, processing & uses), brief account of millets.	**3 lectures**
	Legumes: General account, importance to man and ecosystem.	**3 lectures**
	Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato - morphology, propagation & uses.	**3 lectures**
Unit-II	**Spices:** Listing of important spices, their family and part used, economic importance with specialreference to fennel, saffron, clove and black pepper	**4 lectures**
	Beverages: Tea, Coffee (morphology, processing &uses)	**4 lectures**
	Drug-yielding plants: Therapeutic and habit-forming drugs with specialreference to *Cinchona, Digitalis, Papaver andCannabis.*	**4 lectures**
	Tobacco: Tobacco (Morphology, processing, uses and health hazards)	**2 lectures**
Unit-III	**Oils & Fats:** General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* and Coconut (Botanical name, family & uses)	**4 lectures**
	Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.	**4 lectures**
Unit-IV	**Natural Rubber:** Para-rubber: tapping, processing and uses.	**2 lectures**
	Timber plants: General account with special reference to teak and pine.	**2 Lectures**
	Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).	**2 lectures**

PRACTICALS (20 CLASSES OF 2 HOURS DURATION)

PRACTICALS	**1. Cereals:** Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests). **2. Legumes:** Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests). **3. Sugars & Starches:** Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests). **4. Spices:** Black pepper, Fennel and Clove (habit and sections). **5. Beverages:** Tea (plant specimen, tea leaves), Coffee (plant specimen, beans). **6. Oils & Fats:** Coconut- T.S. nut, Mustard-plant specimen, seeds; tests for fats incrushedseeds. **7. Essential oil-yielding plants:** Habit sketch of*Rosa,* V*etiveria, Santalum* and *Eucalyptus*(specimens/photographs). **8. Rubber:** specimen, photograph/model of tapping, samples of rubber products. **9. Drug-yielding plants:** Specimens of *Digitalis, PapaverandCannabis.* **10. Tobacco:** specimen and products of Tobacco. **11. Woods:** Tectona, Pinus: Specimen, Section of young stem. **12. Fibre-yielding plants:** Cotton (specimen, whole mount of seed to show lint andfuzz;whole mount of fibre and test for cellulose), Jute (specimen, transverse sectionof stem, test for lignin on transverse section of stem and fibre).

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. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publisher

SEMESTER-III BOTANY CORE

Core Course VII: Genetics - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Mendelian genetics and its extension** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.	**10 lectures**
Unit-II	**Extrachromosomal Inheritance:** Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*	**6 lectures**
Unit-III	**Linkage, crossing over and chromosome mapping:** Linkage and crossing over, cytological basis of crossing over; Types of crossing over, recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage. **Variation in chromosome number and structure:** Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy	**12 lectures**
Unit-IV	**Fine structure of gene:** Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus. **Gene mutations:** Types of mutations; Molecular basis of Mutations; Mutagens - physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation.DNA repair mechanisms.	**12lectures**

BOTANY CORE

PRACTICALS (20 CLASSES OF 2 HOURS DURATION)

PRACTICALS	1. Meiosis through temporary squash preparation. 2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis. 3. Chromosome mapping using test cross data. 4. Pedigree analysis for dominant and recessive autosomal and sex linked traits with floral chart. 5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4). 6. Blood Typing: ABO groups & Rh factor.

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. 5thedition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th 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 BOTANY CORE

Core Course VIII: Molecular Biology - 100 marks (Credits-6: Theory-4, Practical-2) THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

UNIT-I	**Nucleic acids : Carriers of genetic information:** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.	**4 lectures**
UNIT-II	**The Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, .RNA Structure- Organelle DNA -mitochondria and chloroplast DNA.The Nucleosome - Chromatin structure-Euchromatin, Heterochromatin.	**8 lectures**
	The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles - bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, Enzymes involved in DNA replication.	**6 lectures**
UNIT-III	**Central dogma and genetic code:** Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of m RNA template), Genetic code (deciphering & salient features)	**2 lectures**
	Mechanism of Transcription: Transcription in prokaryotes; Transcription in eukaryotes.	**4 lectures**
	Split genes-concept of introns and exons, RNA splicing and spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes, exon shuffling.	**5 lectures**
UNIT-IV	**Translation (Prokaryotes and eukaryotes):** 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.	**6 lectures**
	Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptional regulation; Prokaryotes: Regulation of lac-operon and trp-operon	**5 lectures**

PRACTICALS (20 CLASSES OF 2 HOURS EACH)

PRACTICALS	1. Preparation of LB medium and raising *E.Coli.* 2. RNA estimation by orcinol method. 3. DNA estimation by diphenylamine reagent/UV Spectrophotometry. 5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication). 6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs. 7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) 8.Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology ofthe Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th
edition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings.U.S.A. 9th edition.

4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W.H. Freeman and Co., U.S.A. 10th edition

Core Course IX: Plant Ecology and Phytogeography - 100 marks (Credits-6: Theory-4, Practical-2) Theory (each class 1 hour) PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction** Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environmental, concept of hydrosphere and lithosphere and dynamism, homeostasis.	**5 lectures**
	Soil: Importance; Composition; Physical; Chemical and Biological components; Soil profile;	**2 lectures**
	Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.	**2 lectures**
	Light, temperature, wind and fire: Variations; adaptations of plants to their variation.	**4 lectures**
Unit-II	**Population ecology:** Characteristics and Dynamics .Ecological Speciation	**5 lectures**
	Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession - processes, types; climax concepts.	**5 lectures**
Unit-III	**Ecosystems:** Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.	**5 lectures**
	Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.	**5 lectures**
Unit-IV	**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.	**7 lectures**

BOTANY CORE

PRACTICALS	1. Determination of pH of various soil and water samples (pH meter,universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats. 4. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 5(a). Study of morphological adaptations of hydrophytes and xerophytes (four each). (b). Study of biotic interactions of the following: Stem parasite *(Cuscuta),* Root parasite*(Orobanche)* Epiphytes, Predation (Insectivorous plants). 6.Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed). 7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 8.Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 9. Field visit to familiarize 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.

3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

SEMESTER-IV BOTANY CORE

Core Course X: Plant Systematics – 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant identification, Classification, Nomenclature; Biosystematics**	**2 lectures**
	Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access	**6 lectures**
Unit-II	**Taxonomic hierarchy:** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).	**6 lectures**
	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	**6 lectures**
Unit-III	**Systematics- an interdisciplinary science:** Evidence from palynology, cytology, phytochemistry and molecular data.	**6 lectures**
	Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm	**6 lectures**
Unit-IV	**Phylogeny of Angiosperms:** Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).origin& evolution of angiosperms; coevolutionof angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	**8 lectures**

Practical (20 classes, each class of 2h)

Practical	1. 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* 2. Field visit (local) – Subject to grant of funds from the university. 3. 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, G. (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.

Core Course XI:Reproductive Biology of Angiosperms-100 marks(Credits-6:Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks(Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

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.	**2 lectures**
	Anther: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.	**2 lectures**
	Pollen biology: Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.	**5 lectures**
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.	**5 lectures**
	Endosperm: Types, development, structure and functions.	**3 lectures**
	Embryo: Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo;Unusual features; Embryo development in *Paeonia.*	**6 lectures**
Unit-III	**Pollination and fertilization:** Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.	**4 lectures**
	Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility: mixed pollination, bud pollination,	**7 lectures**
Unit-IV	**Seed:** Structure, importance and dispersal mechanisms	**3 lectures**
	Polyembryony and apomixes: Introduction; Classification; Causes and applications.	**4 lectures**
	Germline transformation: Pollen grain and ovules through pollen tube pathway method.	**2 lectures**

Practical (20 classes, each class of 2h)

Practical	1. 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. 2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Calculation of germination in different media using hanging drop method. 3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). 4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus. 5. Intra-ovarian pollination; Test tube pollination through photographs. 6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria. 7. 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, Netherland

SEMESTER-V BOTANY CORE

Core Course XII: Plant Physiology - 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours
[75 marks (Mid Sem 15 + End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant water relationship**: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast,- and apoplastic pathways, root pressure, guttation. Ascent of sap- cohesion-tension theory. Transpiration and factors affecting transpiration, anti transpirants, mechanism of stomatal movement.	**6 lectures**
	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.	**5 lectures**
Unit-II	**Mineral nutrition:** Essential and beneficial elements, macro , micro and trace nutrients, hydroponics, aeroponics(geoponics), mineral deficiency symptoms, roles of essential elements, chelating agents.	**5 lectures**
Unit-III	**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.	**5 lectures**
Unit-IV	**Plant growth regulators:** Bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene.	**10 lectures**
	Physiology of flowering: Photoperiodism, florigen concept, vernalization, seed dormancy.	**4 lectures**
	Phytochrome: Role of phytochrome in photomorphogenesis,.	**5 lectures**

Practical (20 classes, each class of 2h)

Practical	1. Determination of osmotic potential of plant cell sap by plasmolytic method. 2. Determination of water potential of given tissue (potato tuber) by weight method. 3. Study of the effect of light on the rate of transpiration in excised twig/leaf. 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. 5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces). 6. To study the phenomenon of seed germination (effect of light). 7. To study the induction of amylase activity in germinating barley grains. **Demonstration experiments** 1. To demonstrate suction due to transpiration. 2. Fruit ripening/Rooting from cuttings (Demonstration). Bolting experiment/*Avena* coleptile bioassay (demonstration)

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., M0ller, I.M. and Murphy, A (2015). Plant Physiology and Development .Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual Narosa Publishing House, New Delhi.

Core Course XIII: Plant Metabolism - 100 marks (Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)[
75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Concept of metabolism:** Introduction, anabolic and catabolic pathways,regulation of metabolism, role of regulatory enzymes (allosteric and Isozymes).	**5 lectures**
	Carbohydrate metabolism: Synthesis and catabolism of starch. **Lipid metabolism:** Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α- oxidation.	**6 lectures**
Unit-II	**Carbon assimilation:** Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4 pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.	**10 lectures**
Unit-III	**Carbon Oxidation:** Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, NADH shuttle; TCA cycle, mitochondrial electron transport, oxidative phosphorylation, factors affecting respiration.	**6 lectures**
	ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase,	**5 lectures**
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.	**8 lectures**

Practical (20 classes, each class of 2h)

Practical	1. Chemical separation of photosynthetic pigments. 2. Experimental demonstration of Hill's reaction. 3. To study the effect of light intensity on the rate of photosynthesis. 4. Effect of carbon dioxide on the rate of photosynthesis. 5. To compare the rate of respiration in different parts of a plant.. 6. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination. 7.Demonstration of fluorescence by isolated chlorophyll pigments. 8. 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., M0ller, I.M. and Murphy, A (2015). Plant Physiology and Development. SinauerAssociates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

Core Course XIV: Plant Biotechnology - 100 marks(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15+ End Sem 60)]Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant Tissue Culture:** Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones).	**3 lectures**
	Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).	**7 lectures**
Unit-II	**Recombinant DNA technology-I:** Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector;Eukaryotic Vectors (YAC) Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).	**10 lectures**
Unit-III	**Recombinant DNA technology-II:** Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain geneof interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; 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).	**10 lectures**
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); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products-Human Growth Hormone; Humulin; Biosafety concerns.	**10 lectures**

PRACTICALS (20 CLASSES OF 2 HOURS EACH)

PRACTICALS	1. (a) Preparation of MS medium. (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura, Brassica* etc. 2.Study of anther, embryo and endosperm culture, micro propagation, somatic Embryogenesis & artificial seeds through photographs. 3. Construction of restriction map of circular and linear DNA from the data provided. 4. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 5. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savrtomato through photographs. 6.Restriction digestion and gel electrophoresis of plasmid DNA.(Demonstration)

SUGGESTED READINGS

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications Of recombinant DNA. ASM Press, Washington.
4. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication HousePvt. Ltd., New Delhi. 5th edition.
5. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5thedition.
6. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
7. Chawla, H.S. (2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co.Pvt Ltd., New Delhi.
7. Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi

Discipline Specific Elective Courses (DSE)

Semester-V

Discipline Specific Elective (DSE –1):Natural Resource Management – 100 marks (Credits-6:)THEORY (Each class 1 hour): [100 marks (Mid Sem 20+ End Sem 80)]Lectures: 40 Theory

Unit –I	Natural resources: Definition and types. Sustainable utilization : Concept, approaches (economic, ecological and socio-cultural).	**5 lectures**
Unit –II	Land: Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.	**5 lectures**
	Water: Fresh water (rivers, lakes, groundwater, aquifers, watershed);Marine; Estuarine; Wetlands; Threats and management strategies	**6 lectures**
Unit –III	Biological Resources: Biodiversity-definition and types; Significance;Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).	**8 lectures**
	Forests: Definition, Cover and its significance (with special reference toIndia); Major and minor forest products; Depletion; Management.	**6 lectures**
Unit –IV	Energy: Renewable and non-renewable sources of energy Contemporary practices in resource management: EIA, GIS,Participatory Resource Appraisal, Ecological Footprint with emphasis oncarbon footprint.	**6 lectures**
	Resource Accounting; Waste management. National and international efforts in resource management and conservation	**4 lectures**

SEMESTER-V

Discipline Specific Elective (DSE –2) : Biostatstics – 100 marks(Credits-6) THEORY (Each class 1 hour): [100 marks (Mid Sem 20 + End Sem 80)]Lectures: 40 Theory

Unit –I	Biostatistics - definition - statistical methods - basic principles. Variables -measurements, functions, limitations and uses of statistics.	**8 lectures**
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.	**8 lectures**
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.	**10 lectures**
Unit –IV	Correlation - types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression	**8 lectures**
	Statistical inference - hypothesis - simple hypothesis - student 't' test - chisquare test.	**6 lectures**

SEMESTER-VI

Discipline Specific Elective (DSE –3):Stress Biology – 100 marks(Credits-6THEORY (Each class 1 hour):[100 marks (Mid Sem 20 + End Sem 80)]Lectures: 40 Theory

Unit –I	**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.	**12 lectures**
Unit –II	**Stress sensing mechanisms in plants:** Role of nitric oxide. Calcium modulation, Phospholipid signaling	**12 lectures**
Unit –III	**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.	**10 lectures**
Unit –IV	**Reactive oxygen species –** Production and scavenging mechanisms. Acclimation and adaptation of plants.	**6 lectures**

FIRST SEMESTER: MINOR-1 GE-I (Botany)

F.M 75+25=100(04 +02 credits) Duration of Exam: 3 hours

Minor –I Generic Elective-1 (Bio-molecules and Biodiversity in life)

Unit –I	**Cell ,Molecular Biology and Genetics** Ultra-structure of a typical plant cell and its organelles. cell division,types and significance Structure and types of DNA , DNA Replication in Prokaryotes ,Principles of inheritance, Mendel's laws of inheritance,Cytoplasmic inheritance in *Mirabillis* and Snail. Mutation ,Ploidy (Aneuploidy and euploidy)	**Periods :10**
Unit –II	**Microbiology, Phycology ,Mycology& Pathology** **Viruses**: Structure of TMV and bacteriophage , replication of bacteriophages (Lytic and Lysogenic cycle) **Bacteria**: Structure, nutrition, reproduction, recombination, economic importance, **Phycology:** Thallus organisation reproduction and economic importance of algae, and life cycle of the following genera: *Chlamydomonas,Oedogonium, Chara, Vaucheria, Polysiphnia,* **Mycology:** General characteristics of fungi: life cycle of the following genera: *Rhizopus , Penicillium, Puccinia,* **Pathology**: Symptoms, causative organism, and control measures of the following diseases- Damping off of seedlings, Mildew of Pea, Rust of Wheat**.(No developmental stages necessary for life cycle)**	**Periods :10**
Unit –III	**Diversities in Land Plants** **Bryophytes**: General features of Bryophytes, morphology,anatomy , reproduction and life cycle of *Marchantia, Anthoceros, Sphagnum.* **Pteridophytes:** General features of Pteridophytes, morphology, anatomy, reproduction and life cycle of *Selaginella, Equisetum, Marsilea.* **Gymnosperm**: General features of Gymnosperm, morphology, anatomy, reproduction and life cycle of *Cycas, Pinus* and *Gnetum.* **.(No developmental stages necessary for life cycle)**	**Periods :10**
Unit –IV	**Anatomy and Embryology** Tissues: Meristematic and Permanent tissues,Shoot apex organization and the theories related to it,Normal and anomalous secondary growth, Microsporogenesis, megasporogenesis, development of male and female gametophyte, Pollination and fertilization, Types of endosperms, development of typical dicot and monocot embryo.	**Periods :10**

BOTANY

General elective - I

PRACTICAL (20 CLASSES 2 HOURS EACH)

Microbiology, Phycology ,Mycology& Pathology	1. Electron micrographs/Models of viruses - T-Phage and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle. 2. Gram staining. 3. Study of vegetative and reproductive structures of *Chlamydomonas* ,*Oedogonium, Chara, Vaucheria, and Polysiphonia,* temporary slide preparations.
Cytology	Microgrphic stydy of :- Prokaryotic DNA replication, 3D structure of different types iof DNA
Diversities in Land Plants, Anatomy and Embryology.	Permanent slides of Bryophytes,Pteridophytes & Gymnosperms. Stem of dicotyledonos plant with abnormal secondary growth fetures. Embryological permanent slides

Suggested Readings

5. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
6. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
7. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press,Delhi.
8. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, NewDelhi.
9. The embryology of angiosperms.
10. B.P.Pandey (2010) Anatomy of plants

THIRD SEMESTER: MINOR-1 GE-II (Botany)

F.M 75+25=100(04 +02 credits) Duration of Exam: 3 hours

Minor –I Generic Elective-II (Plant and Human Welfare, Plant physiology and Biostatistics)

Unit –I	**Systematics and Economic Botany:** Artificial, natural and phylogenetic system of classification, Economic uses of the following plants in relation to human welfare (in form of short notes) with reference to rice, black gram, mustard, cotton, coffee, Cinchona, Ocimum.	**Periods :6**
Unit –II	**Plant Physiology** **Photosynthesis** : Light & Dark reaction,Mechanism of photophosphorylation; Path of carbon , C_3, C_4 and CAM cycle , **Respiration**; glycolysis , TCA cycle ,electron transport system , Mechanism of oxidative phosphorylation ,hexose monophosphate shunt, **Nitrogen fixation**: symbiotic and non-symbiotic mechanism, , phases of growth, **Phytohormones**: discovery, physiological role of Auxins, Gibberellins, cytokinins and ABA. **Flowering**: Photoperiodism and vernalization.	**Periods :14**
Unit –III	**Environmental Biology** Environment and its components. Communities and their characteristics. **Ecosystems**: Concepts, structure and function of ecosystem; energy flow, bio-geo chemical cycles. Renewable and non-renewable energy resources and their management. Pollution of air, water, soil, noise, and their control and prevention. Global warming, Acid rain and Ozone depletion.	**Periods :10**
Unit-IV	**Biostatistics** Need of statistics in biology, collection of biological data, central tendency- mean, median, mode and their biological significance, dispersion, mean deviation, variance, standard deviation and their biological imporantance, Estimation and hypothesis testing, student's t –test and Chi-square test and their application	**Periods :10**

Internal Assessment: Home Assignment submission

BOTANY

General elective - II

PRACTICAL (20 CLASSES 2 HOURS EACH)

Systematics and Economic Botany:	**Taxonomy of plants belonging to :-** Rubiaceae, Apocynaceae, Asclepiadaceae, Asteraceae solanaceae, Lamiaceae, Brassicaceae And Liliaceae **Economic importance of :-** Rice, Black gram, Mustard, Cotton, Coffee, Cinchona & Ocimum.
Plant Physiology	Determination of osmotic pressure of vacular cells of epidermid of Rhoeo discolor leaf by plasmatic method, Determination of OP of Root / Stem tuber.
Environmental Biology & Biostatistics	Central tendency, Standard Deviation & chi square test

Suggested Readings

1. Systematic botany and Economic Botany by Sing ,Pandey Jain
2. Plant physiology by Arun Chandra Sahu
3. Perspectives in Ecology & Biostatistics by Mandeep Raj & Rajan Sharma

FOURTH SEMESTER: SEC-II F.M 80+20=100(04 credits)

Subject Specific Skill (SEC-II) : Applied Biotechnology (40 periods)

Unit –I	**Genetic Engineering** Structure and Biological importance of DNA and RNA , DNA replication in prokaryotes, Mechanism of Transcription and process of translation. Restriction endonucleases, ligases, linker , prokaryotic and eukaryotic cloning vectors , Introduction of DNA fragments in to vectors , r-DNA technology , Gel Electrophoresis, Blotting techniques and their applications, Bacterial recombination.	**10 lectures**
Unit –II	**Plant Biotechnology** Tissue culture laboratory requirements, techniques, Tissue culture methods, Protoplast fusion, germ plasm conservation, transgenic organisms., Brief idea about application of plant biotechnology	**10 lectures**
Unit –III	**Environmental Biotechnology** Basic concept and issue of environment, A brief idea of air, water pollution and it's control through biotechnology, Green house effect, Acid rain, Ozone depletion and their impact on the environment.	**10lectures**
Unit-IV	**Ethics in Biotechnology** Ethical problems involved in medical and agricultural bio-technology, IPP, IPR, Patenting rules with examples	**10 lectures**

Internal Assessment: Home Assignment submission

SECOND SEMESTER

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC -I)

F. M. 100 (80+20) (04 credits)

ENVIRONMENTAL STUDIES

Unit –I	**Basic concepts of Environmental studies**: The Environment - Air, Water and Land, Environmental factors (Abiotic factors : Light , Temp ,Soil ,Water, Air and Biotic factors) ,Ecological adaptations .Ecological succession (hydrosere and xerosere)	**10 lectures**
Unit –II	**Ecosystem** : Structure and Function ,Energy flow , Food chain , Food web , Ecological Pyramids , Bio-geo –chemical cycles: Hydrological cycle (water) ,Gaseous cycles (Oxygen and Carbon dioxide) Sedimentary cycle (Nitrogen and Sulphur) Population studies: population density,natality,mortality,carrying capacity and growth curves.	**10 lectures**
Unit –III	**Environmental pollution** : Air pollution, Water pollution ,Soil pollution ,Noise pollution, radiation pollution . Depletion of Ozone layer , Green house effects ,Pollution indicators(lichen and algal species)	**10 lectures**
Unit-IV	Renewable and Non-renewable energy resources. Conservation of natural recourses .Forest Conservation and afforestation, Social Forestry, Biodiversity conservation,(*in situ* and *ex situ)* . Pollution control Board and its functions, Environmental awareness .	**10 lectures**

Internal Assessment: written Examination