

# **COURSES OF STUDIES**

**FOR**

**THREE YEAR DEGREE COURSE**

**IN**

**SCIENCE HONOURS**

**DEPARTMENT OF BOTANY**

**Choice Based Credit System(CBCS)**

First & Second Semester Examination – 2017-18

Third & Fourth Semester Examination – 2018-19

Fifth & Sixth Semester Examination – 2019-20



**GOVERNMENT AUTONOMOUS COLLEGE,  
PHULBANI, KANDHAMAL**

### SYLLABI FOR CBCS COURSE

Sem	CORE COURESE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	M.I.L/English (Communication)			GE-1 (Minor-1)
	CORE-II				
II	CORE-III	Environmental Studies			GE-2 (Minor-2)
	CORE -IV				
III	CORE-V		SEC-1 Communicative English and Writing Skill		GE-3 (Minor-1)
	CORE-VI				
	CORE-VII				
IV	CORE-VIII		SEC-2 (Subject specific Skill)		GE-4 (Minor-2)
	CORE-IX				
	CORE-X				
V	CORE-XI			DSE-1	
	CORE-XII			DSE-2	
VI	CORE-XIII			DSE-3	
	CORE-XIV			DSE-4 (Project)	

SEC-1 : To be offered by English Department.

SEC-2 : This is a subject specific skill to be offered by the respective Department.

GE : Minor-1 and Minor-2 is to be decided by the college Based on Subject.

**QUESTION PATTERN FOR MID SEM**

<b>Mid Semester Examination</b>	<b>Full Marks</b>	<b>No. of Short Answer type Questions (2 marks each) (Compulsory)</b>	<b>No. of Long Answer type Questions (8 marks each)</b>	<b>No. of Long Answer type Questions (12 marks each)</b>
Practical Subject	20	6	1	*
Non-Practical Subject	20	4	*	1
Non-Practical Subject	10	1	1	*

**QUESTION PATTERN FOR END SEM**

<b>End Semester Examination</b>	<b>Full Marks</b>	<b>GROUP – A</b>	<b>GROUP - B</b>									
		<b>No. of Short Answer type Questions (2 marks each) (Compulsory)</b>	<b>No. of Long Answer type Questions (8 marks each)</b>					<b>No. of Long Answer type Questions (12 marks each)</b>				
Units -->		I - V	I	II	III	IV	V	I	II	III	IV	V
Non-Practical Subject	80	10	*	*	*	*	*	1	1	1	1	1
Practical Subject	50	5	1	1	1	1	1	*	*	*	*	*
Non-Practical Subject	40	4	1	1	1	1	*	*	*	*	*	*
Practical Subject	20	2	1	1	*	*	*	*	*	*	*	*

- ❖ There is no alternative questions (choice) in Group-A questions (Short Answer type questions). All questions are compulsory.
- ❖ There is internal alternative questions (choice) in each number in Group-B questions (Long Answer type questions). Examinee is to answer one question out of two alternative questions from each number.
- ❖ There is little deviation in question pattern of AECC-1.4 (Eng Communication) & AEEC-3.5 (Soft Skills). Details regarding question pattern of concerned subject is given at appropriate place.)
- ❖ The duration of Mid Sem exam of each paper is 1 hour irrespective of Full marks.
- ❖ The duration of End Sem exam of each paper is 3 hours for 80 marks/50 marks/40 marks & 2 hours for 20 marks.

**YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE**

Three-Year (6-Semester) CBCS Programme (B.Sc. Hons.) (Botany Core)				
Yr.	Sl.No.	Course Structure	Code	Credit Points
FIRST YEAR	SEMESTER-I			
	1	Microbiology and Phycology	C-1.1	4+2
	2	Biomolecules and Cell Biology	C-1.2	4+2
	3	XXX	GE-1.3	4+2
	4	XXX	AECC-1.4	2
	Total			20
	SEMESTER-II			
	5	Mycology and Phytopathology	C-2.1	4+2
	6	Archegonitae	C-2.2	4+2
	7	GE-II (Botany)	GE-2.3	4+2
	8	Environmental Science	AECC-2.4	2
	Total			20
SECOND YEAR	SEMESTER-III			
	9	Anatomy of Angiosperms	C-3.1	4+2
	10	Economic Botany	C-3.2	4+2
	11	Genetics	C-3.3	4+2
	12	XXX	GE-3.4	4+2
	13	XXX	AECC-3.5	2
	Total			26
	SEMESTER-IV			
	14	Molecular Biology	C-4.1	4+2
	15	Plant Ecology and Phytogeography	C-4.2	4+2
	16	Plant Taxonomy & Systematics	C-4.3	4+2
	17	GE-IV (Botany)	GE-4.4	4+2
	18	SEC-II (Nursery and Gardening)	AECC-4.5	2
	Total			26
FINAL YEAR	SEMESTER-V			
	19	Reproductive Biology of Angiosperms	C-5.1	4+2
	20	Plant Physiology	C-5.2	4+2
	21	DSE-I (Biostatistics)	DSE-5.3	4+2
	22	DSE-II (Plant Breeding)	DSE-5.4	4+2
	Total			24
	SEMESTER-VI			
	23	Plant Metabolism	C-6.1	4+2
	24	Plant Biotechnology	C-6.2	4+2
	25	DSE-III (Industrial and Environmental Microbiology)	DSE-6.3	4+2
	26	DSE-IV (Project Work)	DSE-6.4	6
	Total			24
Grand Total			140	

**Notes:**

- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- AECC- Ability Enhancement Elective Course (Skill Based)
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours
- For a 2 credit course, the total teaching hours are: Minimum- 20 Hours, Maximum-30 Hours

## SEMESTER-I

### C-1.1 : MICROBIOLOGY AND PHYCOLOGY

Full Marks – 100  
Mid Sem – 20/1 hr  
End Sem Theory – 50/3 hrs

#### UNIT-I :

**Microbial Characteristics and Methods:** Introduction and developments in the Microbial world: General characteristic of different groups of microbes. Spontaneous generation or Abiogenesis Biogenesis, pasteurization, Germ theory of disease. Methods of sterilization (Physical, Chemical, Gaseous), Culture media (Natural, Semi synthetic, Synthetic, Selective, Differential, Enrichment, Transport), Pure culture techniques, maintenance and preservation of pure culture.

#### UNIT-II :

**Bacteria, Archea & Mycoplasma:** Discovery, general characteristics, distribution & classification of bacteria. Morphology & fine structure of eubacteria (Flagella, Pili, Capsule, Cell Wall, Plasma membrane, Mesosome, Cytoplasmic inclusions, Plasmid, Episome, Nucleoid) Gram positive & Gram negative bacteria.

Reproduction: Vegetative and Asexual.

Genetic recombination: Conjugation, transformation and transduction

General account of Archaeobacteria and Mycoplasma.

#### UNIT-III :

**Viruses & Economic importance of Microorganisms:** Discovery, General characteristics and classification of viruses based on host and nucleic acid. Structure of Tobacco Mosaic Virus and Bacteriophage. Multiplication of viruses: Lytic cycle and Lysogeny. Transmission of viruses.

Economic importance of viruses, Fermentor and Fermentation. Role of microorganism in production of Biofertilisers, organic acids, Antibiotics and Vaccines.

#### UNIT-IV :

**Algae:** General characteristics, distribution; range of thallus organization, classification; Fritsch, and Lee systems (only upto groups); significant contributions of important phycologists (F.E. Fritsch, M.O.P. Iyengar), Origin and evolution of sex in algae, Economic importance of algae.

**Cyanophyta:** General characters and occurrence, cell structure, heterocyst, reproduction & economic importance. Morphology and life-cycle of *Nostoc*.

**Chlorophyta:** General characters, occurrence, structure & reproduction. Morphology and life-cycle of *Chlamydomonas*, *Volvox*, *Ulothrix*, *Oedogonium*.

#### UNIT-V :

**Charophyta:** General characters, structure and life-cycle of *Chara*.

**Xanthophyta:** General characters occurrence, structure life-cycle of *Vaucheria*.

**Phaeophyta:** characteristics, structure and reproduction. Life-cycles of *Ectocarpus*.

**Rhodophyta:** General characteristics, occurrence, cell structure and reproduction. Life-cycle of *Polysiphonia*.

### PRACTICAL

End Sem Practical – 30/3 hrs

#### Expt. -15, Viva Voce- 5 & Lab. Record- 10

1. Study of the morphology and life cycle of the various genera of Algae belonging to the syllabus.
2. Preparation of temp. slides of Algae.
3. Identification and observation of bacteria by Gram Staining.
4. Sterilization and preparation of culture media.
5. Preparation of pure culture.

#### Suggested Books :

1. Ingraham J.L. and C.A. Ingraham Introduction to Microbiology.
2. Singh R.P, (2009) Microbiology –Kalyani Publishers, New Delhi.
3. Algae- O.P Sharma.
4. Dubey R.C. and Maheswari D.K. (2013) A. Text Book Of Microbiology, S. Chand Publications, New Delhi.
5. Sharma P.D Microbiology and Plant Pathology- Rastogi Publications Meerut.
6. Power C.B. and Dagainawlla H.F (2010) General Microbiology, Vol. 1 & Vol. –II, Himalaya Publishing Mumbai.

### 1.2 : BIOMOLECULES AND CELL BIOLOGY

Full Marks – 100  
Mid Sem – 20/1 hr  
End Sem Theory – 50/3 hrs

#### UNIT-I :

##### Biomolecules-I :

**Water:** Structure and properties of water; pH and buffers.

**Carbohydrates:** Nomenclature and classification of carbohydrates. Structure and function of : Monosaccharides- glucose and fructose, Disaccharides- sucrose and lactose, Polysaccharides- Cellulose and starch.

**Amino Acids:** General structure and classification of amino acids.

**UNIT-II :**

**Biomolecules-II :**

**Proteins:** peptide bonds. Primary, secondary, tertiary and quaternary, Structure of proteins. Denaturation and functions of proteins.

**Enzymes:** Nomenclature and classification of enzymes. Structure of enzyme (Holoenzyme, Apoenzyme, Cofactors, Coenzymes and Prosthetic group, active site). Substrate specificity. Mechanism of enzyme action (Activation energy, Lock and Key hypothesis, Induced-fit theory, Michaelis-Menten equation). Enzyme inhibition. Factors affecting enzyme activity.

**UNIT-III :**

**The Cell:** Introduction to Cell Biology. Characteristics of prokaryotic and eukaryotic cells:

**Cell wall and plasma membrane:** Structure, chemical composition & function of cell wall. Cell membrane: Models of membrane organization.

**Cytoskeleton system:** Role and structure of microtubules, microfilaments, intermediate filament.

**UNIT-IV :**

**Cell organelles: Nucleus:** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

**Chloroplast, mitochondria and peroxisomes:** Structural organization; function; Semiautonomous nature of mitochondria and chloroplast, Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

**UNIT-V :**

**Cell division:** Chromosomal events during different stages of mitosis and meiosis. Role of spindle on chromosomal movement. Genetic recombination during meiosis. Cytokinesis. Distribution of cytoplasmic components. Cell cycle and its Regulation.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Preparation of normal, molar & molal solutions.
2. Hydrogen ion concentration and determination of pH of acid and base.
3. Qualitative test for sugar.
4. Qualitative test for lipids.
5. Qualitative test for proteins.
6. Study of mitosis in onion root tip cells by squashing technique.
7. Study of meiosis in onion anther by squashing technique.
8. Karyotypic study of chromosome.

**Suggested Books :**

1. Nelson D.L. & Cox. Lehninger M.M. - Principles of Biochemistry
2. Voet Donald, Voet J.G. and Pratt C. W. - Fundamentals of Biochemistry.
3. Conn Eric E., Stumpf P.K., Bruening G. & Doi R.H. (2007) Outlines of Biochemistry-. John Wiley & Sons, Singapur
4. Jain J.L., Jain S. & Jain Nitin - Biochemistry
5. Satyanarayanan U.- Biochemistry
6. Cooper G.M., Housman R.E. - The Cell- A. Molecular Approach.
7. DeRobertis E.D.P., and DeRobertis E.M. F. - Cell and Molecular Biology
8. Rastogi S.C.- Cell Biology

**SEMESTER –II**

**C-2.1 : MYCOLOGY AND PHYTOPATHOLOGY**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Introduction to true fungi:**

Definition General characteristics: Affinities with plants and animals. Thallus organization: Cell wall composition; Nutrition; Classification. (Anisworth)

**Zygomycota:** General Characteristics: Thallus organization: life cycle with reference to *Mucor*.

**Oomycota:** General characteristics; Life cycle and of *Phytophthora*, *Albugo*.

**UNIT-II :**

**Ascomycota:** General characteristics. Heterokaryosis and parasexuality; life cycle of *Saccharomyces*; *Penicillium*, and *Aspergillus*.

**Basidiomycota:** General characteristics: life Cycle of *Puccinia*, *Agaricus*:

**UNIT-III :**

**Deuteromycota & Lichen:** Alternaria, Cercospora. Lichen- Occurrence; General characteristics, growth forms and range of thallus organization, Nature of association of algal and fungal partners. Reproduction and Economic importance.

**UNIT-IV :**

**Applied Mycology:** Role of fungi in Biotechnology, Application of fungi in food industry (Flavour and texture, fermentation, baking, organic acids), Mycotoxins Biological control.

**UNIT-V :**

**Phytopathology:** General symptoms of plant diseases; mode of infection; Host-Pathogen relationships; disease cycle; prevention and control of plant diseases, Fungal diseases – Late blight of potato, Blast of rice, Tikka Disease of Ground nut, Red Rot of Sugarcane. General Account of plant disease management.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Study of the morphology and anatomy of the genera belonging to Fungi included in the syllabus.
2. Study of different types of plant diseases caused by pathogens belonging to different classes of Fungi. T.S. of infected plant parts (Leaf, Stem.)
3. Study of growth forms of lichens (Crustose, Foliose and Fruticose).

**Suggested Books :**

1. Singh. R.S. (2009) Plant Disease oxford & I.B.H. Publishing Co. Pvt. Ltd., New Delhi.
2. Sharma P.D. Plant Pathology, (2004) Rastogi Publications, Meerut.
3. Sharma O.P.. Text Book of Fungi.(2002) Tata Mc. Graw Hill Publications Meerut.

**C-2.2 : ARCHEGONITAE**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Bryophytes:** General characteristics; Classification by Bower; Distribution and life Cycle of *Marchantia*, *Anthoceros* and *Sphagnum*. Progressive sterilization of sporogenous tissue.

**UNIT-II :**

**Pteridophytes-I:** General characteristics, classification by Smith, morphology, anatomy and reproduction of *Psilotum*, *Isoetes*, *Equisetum* and *Marsilea*.

**UNIT-III :**

**Pteridophytes-II:** Morphology, anatomy and reproduction of *Selaginella*, Heterospory & Seed Habit. Telome theory, Stellar Evolution.

**UNIT-IV :**

**Gymnosperms:** General characteristics, classification by Chamberlain. Morphology, anatomy and reproduction of *Pinus*, *Ginkgo* and *Gnetum*.

**UNIT-V :**

**Fossils:** Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia*, *Lepidodendron* *Lyginopteris* and *Cycadeoidea*.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Study of the morphology and anatomy of *Marchantia*, *Anthoceros* and *Sphagnum*.
2. Study of the morphology and anatomy of *Psilotum*, *Isoetes*, *Equisetum*, *Selaginella* and *Marsilea*.
3. Study of the morphology and anatomy of *Pinus*, *Ginkgo* and *Gnetum*.
4. Preparation of permanent slides of the above genera belonging to Bryophyta, Pteridophyta & Gymnosperms in the syllabus.
5. Study of slides of fossils included in the syllabus.

**Suggested Books :**

1. Pteridophyta – P.C. Vasistha, A.K. Sinha & A. Kumar S. Chan Publications, New Delhi, India.
2. An Introduction to Embryophyta Vol. I & II- N.S. Parihar Central Book Department, Allahbad.
3. A Text Book of Botany- V. Singh, P.C. Pandey & D.K. Jain, Rastogi Publications, Meerut.

**GE-2.3 : PLANT DIVERSITY**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Algae:** General characteristics, classification proposed by Fritsch. Occurrence, structure, reproduction and life cycle of:

- |                             |   |
|-----------------------------|---|
| (i) Cyanophyta-Nostoc       | (ii) Chlorophyta –Chlamydomonas and Chara |
| (iii) Xanthophyta-Vaucheria | (iv) Phaeophyta-Ectocarpus                |

Range of thallus organization in algae. Origin and evolution of sex in algae. Economic importance of algae.

**UNIT-II :**

**Fungi & Lichen:** Fungi-General Characteristics, Classification Proposed By Anisworth. Occurrence, Structure, Reproduction And Life Cycle of:

- (i) Mastigomycotina: Phytophthora : Symptoms And Disease Control Of Late Blight Of Potato.
  - (ii) Ascomycotina: Saccharomyces, Penicillium
  - (iii) Basidiomycotina: Puccinia, Agaricus. Symptoms And Disease Control of Rust of Wheat.
- Economic Importance of Fungi.

Lichen- structure, reproduction and economic importance.

**UNIT-III :**

**Bryophyta:** General Characteristics, Morphology, Anatomy and Reproduction of :

- (i) Hepaticopsida: Marchantia
  - (ii) Anthocerotopsida: Anthoceros
  - (iii) Bryopsida : Sphagnum
- Economic importance of bryophytes.

**UNIT-IV : Pteridophyta:**

General Characteristics, Morphology, Anatomy and Reproduction and life cycle of :

- (i) Psilophytopsida: Rhynia
- (ii) Lycopsida: Selaginella
- (iii) Sphenopsida: Equisetum
- (iv) Pteropsida: Marsilea

Stelar system and evolution of stele in pteridophytes. Heterospory and seed habit in pteridophytes.

**UNIT-V :**

**Gymnosperms and Paleobotany:**

General Characteristics. Distribution, Morphology, Anatomy, Reproduction and Life Cycle of :

- (i) Cycadophyta: Cycas
- (ii) Coniferophyta: Pinus
- (iii) Gnetophyta: Gnetum

Economic importance.

Fossil and Fossilization Process : Fossilization process, morphology, anatomy of lepidodendrom, lyginopteris and cycadeoidea.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Study of the morphology and anatomy of the various genera belonging to Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms belonging to the syllabus.
2. Study of different types of plant diseases caused by pathogens belonging to different classes of fungi, T.S of infected parts (Leaf & stem)
3. Study of growth forms of lichens (Crustose, Foliose and fruticose)

**Suggested Books :**

1. Smith G.M. Cryptogamic Botany- Vol. I & Vol. II
2. Singh V., Pandey P.C. and Jain D.K. A. Textbook of Botany.
3. Mitra J.N. and Choudhury S.K. Moulik Studies in Botany Vol. I.
4. Nath Rabindra, Kalyani Modern College Botany Vol. I & II.

**AECC-2.4 : ENVIRONMENTAL STUDIES**

**Full Marks – 50**

**Mid Sem – 10/1 hr**

**End Sem – 40/3 hrs**

**UNIT-I :**

**Concept of environment :** Ecology; Ecosystem; types and components of the ecosystem. Ecological adaptations of plants and animals

**UNIT-II :**

**Functional aspects of ecosystem :** Trophic level, food chain, food web, energy flow in the ecosystem, ecological pyramids, Biogeochemical cycles: Water cycle and Nitrogen cycle

**UNIT-III :**

**Environmental Pollution:** Source, causes and concept of air, water, noise, soil, pollution, Sewage & Sewage treatment, green house effect, Acid rain, Ozone layer depletion

**UNIT-IV :**

**Conservation of Natural Resources :** Resources, renewable & non renewable resources; soil, soil erosion and its conservation; Forest, deforestation; afforestation, conservation of Forest

**THIRD SEMESTER**

**C-3.1 : ANATOMY OF ANGIOSPERMS**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**



**UNIT-I :**

**Introduction and scope of anatomy, Tissue:** Application of plant anatomy in systematics.

**Tissues:** Meristem and meristematic tissue: (Classification, distribution, structure and function), Permanent Tissues: Simple tissue (Structure function and distribution of parenchyma, collenchymas, sclerenchyma) complex tissue (xylem and phloem), Secretary tissue: Laticiferous, glandular, Hydathodes and Nectaries.

**UNIT-II :**

**Structural organization of Root, Stem and Leaf:** Organization of root apex (Apical cell theory, Histogen theory, korpor-kappe theory); Quiescent centre, Root cap, anatomy of dicot and monocot root. Organization of shoot apex (Apical cell theory, Histogen theory, Tunica corpus theory) Cytohistological zonation, root-stem transitions, origin of lateral root. Anatomy of dicot and monocot stem. Anatomy of dicot and monocot leaf, Karnz anatomy.

**UNIT-III :**

**Protective and ground tissue system :** Introduction to tissue system: Epidermal tissue system (Cuticle, epidermis), structure, classification, distribution and function of stomata, unicellular and multi cellular trichomes, glandular and non glandular hairs. Ground or fundamental tissue system. Structure and function of cortex, endodermis, pericycle, pith and pith rays.

**UNIT-IV :**

**Mechanical and Vascular tissue system:** Principle, organization, distribution and function of mechanical tissues in angiosperms. Structure and function of primary vascular tissue, procambium, fascicular cambium, origin and duration of cambium, cambium in monocots, Types of vascular bundles and their arrangement in roots and stem. Structure, organization and function of periderm in root and stem, Rhytidome, lenticels.

**UNIT-V :**

**Secondary growth and ecological anatomy:** Normal secondary growth in stem and root: Dendrochronology, annual ring, tyloses, sapwood and heart wood. Anomalous secondary growths (adaptive and non adaptive) abnormal secondary growth in dicot stem (Bignonia, Aristolochia, Amaranthus, Bougainvillea, Boerhaavia, Achyranthus), Monocot stem (Dracaena). Ecological anatomy: Anatomy of Hydrophytes, Xerophytes.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Study of anatomical details through permanent slides/temporary stain mounts/macerations/museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchymas 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 tissue 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. Secretary tissues: cavities, lithocysts and laticifers.
13. Study of anomalous secondary growth of different plant included in the syllabus.

**Suggested Books :**

1. Dickison, W.C. (2002), Integrative Plant Anatomy. Harcourt Academic press, USA.
2. Esau, K. (1977). Anatomy of seed plants. John Wiley & Sons, Inc, Delhi.
3. Pandey B.P. Plant Anatomy, S. Chand Publication.
4. Haberlandt- Anatomy
5. A Text Book of Botany, S.N. Pandey & Chadha, Vikas Publishing house Pvt. Ltd.

**C-3.2 : ECONOMIC BOTANY**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Origin of Cultivated Plants:** Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity, evolution of new crops/varieties, importance of germplasm diversity.

**UNIT-II :**

**Cereals, legumes, Sugar and Starches:** Wheat and Rice (Origin, morphology, processing & uses).

Legumes: General Account, importance to man and ecosystem.

Sugar & Starches: Morphology and processing of sugarcane, Patato- (Morphology, propagation & uses).

**UNIT-III :**

**Spices, Beverages, Durg-yielding plants :** Listing of important spices, their family and part used, economic importance with special reference to clove and black pepper.

Beverages: Tea, Coffee (Morphology, processing & uses)

Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona and Papaver.

Tobacco: Tobacco (Morphology, processing, uses and health hazards).

**UNIT-IV :**

**Oils & Fats & Medicinal plants:** General description, extraction, their uses and health implications of groundnut, coconut (Botanical name, family & Uses)

Medicinal plants: General accounts botanical name and uses of Tulsi, Aloe, Neem, Rouvolfia.

**UNIT-V :**

**Natural Rubber, Fibres and timber plants:** Rubber plant, morphology tapping, processing and uses.

Timber plants: General account with special reference to Teak and Sal.

Fibres: Cotton and jute (Morphology, extraction and uses)

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Cereals: Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Green Gram & Black Gram: Habit, fruit, seed structure.
3. Sugar & 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, Clove (Specimen).
5. Beverages: Tea (specimen, tea leaves), Coffee (specimen).
6. Oils & Fats: Coconut, Mustard-plant specimen, seeds, tests for fats in crushed seeds.
7. Rubber: Specimen, photograph/model of tapping, samples of rubber products.
8. Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis, Cinchona.
9. Tobacco: Specimen and products of Tobacco.
10. Medicinal plants : Tulsi, Aloe, Turmeric, Neem, Rouvolfia (Specimen)
11. Woods: Tectona, Sal: (Specimen).
12. Fibre-yielding plants: Cotton (Specimen and test for cellulose), Jute (Specimen test for lignin).

**Suggested Books :**

1. Kochhar, S.L. (2012), Economic Botany in Topics, Macmillan & Co. New Delhi, India.
2. Chrispeels, M.J. and Sadava, D.E. (2003), Plants Genes and Agriculture. Jones & Bartlett publishers.
3. Pandey, B. P. (2012). Economic Botany, S. Chand & Company Ltd. New Delhi.
4. Singh, V., Pandey, P.C. and Jain, D.K. (2005). Economic Botany. Rastogi publications, Meerut, India.

**C-3.3 : GENETICS**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Mendelian genetics and its extension:** Mendel's experiments and principles of inheritance, Chromosomal theory of inheritance, other patterns of inheritance : incomplete dominance and co-dominance multiple alleles, Lethal alleles, Pleiotropy, Penetrance and Expressivity.

**UNIT-II :**

**Cytoplasmic Inheritance:** Characteristics of cytoplasmic inheritance. Plastid inheritance in *Mirabilis Jalapa* mitochondrial inheritance in yeast. Cytoplasmic male sterility, maternal effects of shell coiling in snail, infective heredity: Kappa Particles in paramecium.

**UNIT-III :**

**Linkage and Crossing over:** Linkage: coupling and repulsion, complete and incomplete linkage, linkage maps, sex linkage: Characteristics of sex-linkage inheritance to inheritance of white eye in *Drosophila*.

Crossing over: Molecular Mechanism, Cytological basis of crossing over, Recombination frequency, two point and three point cross, interference and coincidence.

**UNIT-IV :**

**Variation in Chromosome number:** Euploidy: Haploidy: polyploidy, autopolyploidy and allopolyploid, Aneuploidy: monosomics, nullisomics, trisomics. Cytological behavior of euploids and aneuploids. Application of polyploids.

**Variation in chromosome structure:** Chromosomal aberrations: Origin, Types: Deletion, Duplication, Inversion and Translocation. Genetic effects of chromosomal aberrations.

**UNIT-V :**

**Gene Mutation :** Types, Spontaneous and induced mutation, molecular basis of mutation, mutagens: Physical and chemical (Base analogues, deamination agent, alkylating agents), Detection of mutation: detection of sex linked lethal by CIB method and attached 'X' method of *Drosophila*.

**Population and Evolutionary Genetics:** Gene and genotypic frequency, Hardy Weinberg's law, Genetic drift, Speciation, Genetic variation.

**PRACTICAL**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Mendel's laws through seed ratios. Laboratory exercise in probability and chi-square analysis.
2. Chromosome mapping using test cross data.
3. Pedigree analysis.
4. Incomplete dominance and gene interaction through seed ratios (9:7,9:6:1,13:3,15:1, 12:3:1,9:3:4)
5. Study of aneuploidy: Down's Klinefelter's and Turner's syndromes.
6. Photographs/permanent slides showing translocation Ring, Laggards and Inversion Bridge.
7. Determination of allelic frequency and genotypic frequency.

**Suggested Books :**

1. Gardner, E.J, Simmons, M.J, Snustad, D.P (1991), Principles of Genetics, John Wiley & Sons, India, 8<sup>th</sup> edition.
2. Snustad, D.P and Simmons, M.J. (2010), Principles of Genetics, John Wiley & sons inc. India, 5<sup>th</sup> edition.
3. 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. 10<sup>th</sup> Edition.
4. Verma, P. S., and Agarwal (2009), Genetics, S Chand and Company Ltd 1<sup>st</sup> multi colour edition, New Delhi.
5. Singh, B. D., (2009) Genetics, Kalyani Publishers, 2<sup>nd</sup> edition, New Delhi.
6. Gupta, P. K. (1998), Genetics, Rastogi Publication, Meerut.

## FOURTH SEMESTER C-4.1 : MOLECULAR BIOLOGY

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

**UNIT-I :**

**Nucleic Acids:** Proprieties of genetic materials, The search for genetic material : Evidence of DNA as genetic material (Experiments of Griffith, Avery, Macleod and Mc Carty, Harshey and chase), RNA as genetic material (Fraenkel- Contrat's Experiment) Genetic materials in Eukaryotes, constituents of nucleic acids. (Phosphoric acids, Pentose sugar, Organic bases, nucleosides and nucleotides).

Structure of DNA (Double helix model), alternate forms of DNA double helix (A,B and Z form), Structure of RNA.

**UNIT-II :**

**Replication of DNA:** DNA replication: Experimental evidence for semi conservative DNA replication in E.Coli (Meselson and Stahl's experiment), Enzymes, & protein involved in DNA replication. (DNA polymerase, primase, ligase, Helicase, SS Binding Protein), Mechanism of DNA replication.

**UNIT-III :**

**Chromosomes :** Chromosome number size, morphology and ideologram fell chromatin and heterochromatin, chemical composition C-value paradox, histones and non histones, origin of chromatin fibres, nucleosome core, linker DNA, polytenes, salivary and Lampbrush chromosome.

Genetic Code: Properties of genetic code, wobble hypothesis.

**UNIT-IV :**

Expression of gene : Central dogma, Mechanism of transcription in prokaryotes, post-transcriptional processing of m-RNA. Translation : Process of translation in prokaryotes and difference between prokaryotes and eukaryotes, post translation modifications.

**UNIT-V :**

**Regulation of gene expression:** Introduction and levels of regulations of gene expression. Regulations of gene action in prokaryotes: Transcriptional control mechanisms: negative control (inducible and repressible operon) positive control (Inducible and repressible).regulation of gene action in eukaryotes hormonal control of gene expression, gene silencing.

## PRACTICAL

End Sem Practical – 30/3 hrs

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Preparation of LB medium and raising E.coil.
2. Isolation of genomic DNA from E. coil.
3. DNA isolation and RNA estimation by orcinol method.
4. DNA estimation by diphenylamine reagent/UV spectrophotometry
5. Study of DNA replication mechanisms through photographs (Rlling 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 etc al, Griffith's Hershey & Chase's and Fraenkel & Contrat's experiments),
8. Study of the following through photographs: Assembly of Spliceosome machinery: Splicing mechanism in group I & Group II introns; Ribozyme and Althervative splicing.

**Suggested Books :**

1. Watson, J.D. Baker, T.A. Bell, S.P. Gann, A. Leine, M. Losick, R. (2007), Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL press, New York, U.S.A., 6<sup>th</sup> edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and sons Inc. U.S.A. 5<sup>th</sup> Edition.
3. Klug, W.S. Cummings, M.R. Spencer, C.A. (2009), Concepts of Genetics. Benjamin Cummings. U.S.A. 9<sup>th</sup> edition.
4. Russell, P. J. (2010). IGenetics- A Molecular Approach. Benjamin Cummings, U.S.A., 3<sup>rd</sup> 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 10<sup>th</sup> edition.
6. Pal, Jayanta, K. Ghaskdbi (2009) Fundamental of molecular biology Oxford University press New Delhi.

**C-4.2 : PLANT ECOLOGY AND PHYTOGEOGRAPHY**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Introduction and components of Environment :** Concept and scope of ecology, autoecology, Synecology, system ecology, levels of organization. Inter-relationship between living world and environment. Components of environment (Hydrosphere, lithosphere biosphere). Concept of biological stress and strain, dynamism, homeostasis, concept of habitat and niche.

**UNIT-II :**

**Ecological Factors:** Climatic factors (Light and temperature, their variations, precipitation, humidity of air, atmospheric gases and wind-their variations, and adaptations of plants. Edaphic factor : Importance of soil, formation and composition, soil profile, physical properties of soil, soil erosion and conservation. Relationship among organisms, Positive interactions (Mutualism, Commensalism, Proto-Co-operation), Negative interactions (Exploitation, Antibiosis, Competition).

**UNIT-III :**

**Population and Community ecology:** Basic concept, characteristics (Size and density, dispersion, age structure, natality and mortality) Biotic Potential, population dynamics. Community characteristics: Analytical and Synthetic characters-Methods of study of plant community (Raunkiaer's method and phytosociological method), species diversity. Community dynamics: General causes and process of succession (Hydrosere and xerosere).

**UNIT-IV :**

**Ecosystems and pollution ecology:** Kinds of ecosystem; structure and components of ecosystem (food chain, food web, ecological pyramids). Functional aspects of ecosystem: Principle and models of energy flow (Single channel and Y shaped channel), productivity, ecological efficiency, biogeochemical cycles of nitrogen, carbon and phosphorus.

**UNIT-V :**

**Conservation and Phytogeography:** Concept and classification of resources (Renewable, non renewable, their conservation and management). Concept of biodiversity, their depletion and conservation. Social forestry and Agro forestry. Phytogeography: Continental drift, endemism major terrestrial biomes of the world (Tropical, rain forest, Grassland, Mangroove and Tundra). Phytogeographical division (Vegetation) regions of India. Vegetation of Odisha.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Determination of pH of various soil and water samples (pH meter, universal indicator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter from two soil samples.
3. To estimate dissolve oxygen content by Winkler's method.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes.  
(b) Study of biotic interactions of the following: Lichens, Stem parasite (cuscuta), Root parasite (Orabanche), Epiphytes-predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method.
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with (Raunkiaer's frequency distribution law), density abundance in the college campus.
7. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus
8. Filed visit to familiarize students with ecology of different sites.
9. Study of water holding capacity, porosity and moisture content of two different classes of soil.
10. To estimate the salinity of water samples.

**Suggested Books :**

1. Odum, E.P (2005) Fundamentals of ecology, Cengage Learning India Pvt. Ltd., New Delhi 5<sup>th</sup> edition.
2. Singh, J.S. Singh S.P Gupta, S (2006). Ecology Environment and Research Conservation, Anamaya publication, New Delhi, India.

3. Sharma, P.D. (2010), Ecology and Environment. Rastogi publications, Meerut, India, 8<sup>th</sup> edition.
4. Wilkinson, D.M. (2007) Fundamental processes in Ecology: An earthy systems Approach. Oxford University press, U.S.A.
5. Kormondy, E.J. (1996), Concepts of ecology. PHI Learning Pvt. Ltd. Delhi, India, 4<sup>th</sup> Edition.
6. Ms. S. Arora – Fundamental of Environmental Biology
7. Odum. E.P (1993), Basic Ecology, Sunders college publishing, Japan.
8. Dash M.C. (1995). Fundamentals of Ecology. Tata. Mc. Graw-Hill Publishing Company, Ltd. New Delhi.
9. Sukia, R.S & Chandel P.S. (2005), A. Text Book of Plant Ecology, S. Chand and Company Ltd. New Delhi.

### **C-4.3 : PLANT TAXONOMY & SYSTEMATICS**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

#### **UNIT-I :**

##### **Taxonomic and systematics:**

Basic concept of Taxonomy and systematic, Goals and aims of plant systematic: Hierarchical categories of taxonomy, Herbarium techniques: Plant collection, pressing, drying, poisoning, mounting, labeling, storage and fumigation. Important botanical gardens of world and India. Plant identification: Character consider for identification, identification with Keys.

#### **UNIT-II :**

**Botanical nomenclature :** Concept of taxa (Family, genus, species). Concept of species (Taxonomic, biological, genetic, evolutionary). Plant nomenclature: Principle and rule of ICN (Typification, author citation, principle of priority and its limitations, valid publication, rejection of names and synonyms, names of hybrids).

#### **UNIT-III :**

**Systems of classification:** Artificial system of Classification by Linnaeus, Natural systems of Bentham and Hooker, Phylogenetic system of classifications by Hutchinson and Engler and Prantle.

#### **UNIT-IV :**

**Modern trends in plant taxonomy:** Taxonomy in relation to anatomy, embryology, palynology. Cytotaxonomy, Chemo Taxonomy, Origin and evolution of Angiosperms.

#### **UNIT-V :**

**General Accounts and floral structure:** Dicot families : Magnoliaceae, Rosaceae, Rutaceae, Cucurbitaceae, Rubiaceae, Apocynaceae, Convolvulaceae, Lamiaceae, Acanthaceae and Asteraceae. Monocot families: Orchidaceae, Musaceae, Zingiberaceae, Cyperaceae, Poaceae.

### **PRACTICAL**

**End Sem Practical – 30/3 hrs**

#### **Expt. -15, Viva Voce- 5 & Lab. Record- 10**

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 of classification).
  - a. Dicot families : Magnoliaceae, Rosaceae, Rutaceae, Cucurbitaceae, Rubiaceae, Apocynaceae, Asclepiadaceae, Convolvulaceae, Lamiaceae, Acanthaceae and Asteraceae
  - b. Monocot families: Orchidaceae, Musaceae, Zingiberaceae, Cyperaceae, Poaceae
2. Filed Visit- for collection and identification of plants
3. Collection, identification and preparation of herbarium of plant species.

#### **Suggested Readings**

1. Singh G. (2012) plant systematic: Theory and practice. Oxford & IBH Pvt. Ltd, New Delhi. 3<sup>rd</sup> edition.
2. Jeffry, 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. 2<sup>nd</sup> 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.
6. Sharma O.P (1993) Plant Taxonomy. Tata Mc. Graw- Hill Publishing company limited, New Delhi.
7. Pandey, H.P (2009). Plant Taxonomy (Principle and practice). Silverline publications, New Delhi.
8. Singh. V. & Jain D.K. Taxonomy of Angiosperms by Rastogi publication, Meerut.
9. Saxena, N.B and Saxena Samindra -Plant Taxonomy Pragati prakashan, Meerut (8<sup>th</sup> edition -2012)

### **GE-4.4 : ANGIOSPERMS AND DEVELOPMENTAL BOTANY**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

#### **UNIT-I :**

**Taxonomy of Angiosperms:** Taxonomic categories, concept of species, Nomenclature, Elementary idea about ICN, classification of flowering plants proposed by (i) Bentham and Hooker (2) Engler & Prantle. General Account and floral character of the following families: Magnoliaceae, Lamiaceae, Apocyanaceae, Musaceae. Poaceae.

**UNIT-II :**

**Embryology of Angiosperms and Plant breeding:** Male gametophytes & Microsporogenesis, female gametophytes and megasporogenesis. Process of fertilization, structure and development of different types of endosperms, structure and development of monocot and dicot embryo. General account of plant breeding, pure line and mass selection.

**UNIT-III :**

**Anatomy and Tissue culture:** Meristematic and permanent tissue, Epidermal, Fundamental, conductive tissue systems. Secondary growth in dicot stem and root. Adaptive and non-adaptive anomalous secondary growth in stem: Bignonia Bougainvillea, Amaranthus and Boerhaavia. Concept of totipotency, principles and procedure of plant tissue culture

**UNIT-IV :**

**Economic Botany:** Origin and diversification of domesticated plants. General account of botany, cultivation and economic importance of Rice, Jute, Sugarcane, Green gram, Coconut. General account of the following medicinal and timber yielding plants; Azadirachta, Ocimum, Aloe, Rawolfia, Shorea, Tectona

**UNIT-V :**

**Plant Physiology:** Osmosis, plasmolysis, concept of water potential, transpiration, water absorption, ascent of sap. Enzyme & enzyme action. Photosynthesis, translocation of photosynthates. Biological nitrogen fixation phytohormones (Auxins, Gibberellins, Cytokinins)

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Study of flowering plants belonging to the dicot families in the syllabus.
2. Study of flowering plants belonging to the monocot families in the syllabus.
3. Study of embryological slides related to the syllabus.
4. Study of anomalous secondary growth of different plant species included in the syllabus (*Bignonia, Bougainvillea, Amaranthus and Boerhaavia*).
5. Study of economically important plants included in the syllabus.
6. Determination of osmotic pressure by plasmolytic method.
7. Determination of diffusion pressure deficit (DPD) of storage tissue.
8. To measure the ratio between transpiration and absorption by T/A apparatus.
9. Measurement of rate of photosynthesis by using Willmott's Bubbler under different light qualities and CO<sub>2</sub> concentration.
10. Microscopic observation of opening and closing of stomata.

**Books Recommended :**

1. Heywood V.H Current concepts in plant Taxonomy.
2. Jeffery C An Introduction to plant Taxonomy. Cambridge Press, Cambridge.
3. Sambamurty A.V.S.S. Taxonomy of Angiosperms.
4. Subramaniam N.S Modern Plant Taxonomy.
5. Singh V. & Jain D.K. Taxonomy of Angiosperms – Rastogi Publications.
6. Bhojwani S.S. & Bhatnagar S.P. Embryology of Angiosperms.
7. Singh V., Pande P.C. & Jain D.K. Embryology of Angiosperms .
8. Maheswari P. An Introduction to Embryology of Angiosperms.
9. Pandey B.P. Plant Anatomy.
10. Vasistha P.C. A. Text Book of Plant Anatomy.
11. Singh B.D. Applications of Biotechnology.
12. Pandey B.P. Economic Botany.
13. Kochhar S.L. Economic Botany in Tropics-, Macmillan & Company, New Delhi India.
14. Srivastava H.N. Plant Physiology.
15. Verma V. Plant Physiology.

**AEEC-4.5 (SEC –II) : NURSERY AND GARDENING**

**Full Marks – 50  
Mid Sem – 10/1 hr  
End Sem – 40/3 hrs**

**UNIT-I :**

Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

**UNIT-II :**

Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology - seed testing and certification.

**UNIT-III :**

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings -Hardening of plants – green house - mist chamber, shed root, shade house and glass house.

**UNIT-IV :**

**[8 lectures**

Gardening: definition, objectives and scope - different types of gardening –landscape and home gardening - parks and its components - plant materials and design – computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

**UNIT-V :**

**[6 lectures**

Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

**Suggested Books :**

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

## **FIFTH SEMESTER**

### **C-5.1 : REPRODUCTIVE BIOLOGY OF ANGIOSPERMS**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Introduction, Microsporogenesis and Male gametophyte:** Microsporangium; Anther wall: Structure and function, sporogenous tissue, microspore tetrads. Male gametophyte: structure of pollen grain, Development of Male gametophyte, pollen sterility.

**UNIT-II :**

**Megasporogenesis, Female gametophyte:** Megaspores: Types of ovules, integuments, micropyle, nucellus, special structures (endothelium, Obturator, aril, caruncle) Hypostage, epistage, megasporogenesis.

**Female gametophyte:** Mono, bi and tetrasporic embryo sacs, Detailed structure of mature polygonum type of embryo sac (Synergids, egg, antipodals, central cell). Haustorial behaviour of embryo sac. Nutrition to embryo sac.

**UNIT-III :**

**Fertilization and Endosperm:** Path of pollen tube, Entry of pollen tube into the ovule and embryo sac, pollen tube discharge, syngamy, double fertilization and triple fusion.

**Endosperm and Embryo:** Endosperm: Development of endosperm Types (Nuclear, Cellular, Helobial & Mosaic), endosperm haustoria, Xenia & Metaxenia.

**UNIT-IV :**

**Embryo and self incompatibility:** Embryo development in dicots and monocots. Details of development of typical dicot and monocot embryo, suspensor, nutrition to embryo, embryo development in Paeonia.

**Self incompatibility:** Basic concepts (interspecific, intraspecific, homomorphic, Heteromorphic, GSI and SSI); Methods to overcome self-incompatibility.

**UNIT-V :**

**Polyembryony and development of seeds:** Polyembryony: Origin, classification, causes and practical applications of Polyembryony. Apomixis: Types and significance. Seed : Development of Seed.

## **PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Anther: Wall and its ontogeny; Tapetum (Amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehiscent anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (Slides/Photographs, fresh material), ultra structure of pollen wall (micrograph); Pollen viability; Tetrazolium test. Germination: calculation of percentage germination in different media using hanging drop method.
3. Various types of Ovules: Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmie, bitegmie, Tenuinucellate and crassinucellate: special structures: Endothelium, obturator, hypostase, caruncle and aril (Permanent slide/ specimens/photographs).
4. Female gametophyte through permanent slides/photographs: Types, ultra structure of mature egg apparatus.
5. Intra-ovarian pollination: Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm (cucurbita pepo) seed.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various development stages; study of suspensor through electron micrographs.
8. To trace the path of pollen tube.

**Suggested Books :**

1. Bojwani, S.S., Bhatnagar, S.P And Dant, P.K.,(2015). The Embryology of Angiosperm, Vikas Publishing House. Delhi, 5<sup>th</sup> 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 I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Singh. V. Pandey P.C. and Jain D.K. Embryology.
6. Singh, Pandey and Jain (2011), Rastogi Publication, Meerut.

### C-5.2 : PLANT PHYSIOLOGY

Full Marks – 100  
Mid Sem – 20/1 hr  
End Sem Theory – 50/3 hrs

#### UNIT-I :

**Plant water relations:** Diffusion, osmosis, plasmolysis, imbibition, water potential and its components, Mechanism of absorption of water, path of water across the roots, Transpiration : Types, mechanism of stomatal movement, factors effecting transpiration,significance of transpiration, Antitranspirants.

#### UNIT-II :

**Mineral nutrition and Mineral salt absorption :** Essential elements: Macro and micro elements : their functions and deficiency symptoms. Mineral salt absorption: mechanisms of ion uptake, Passive uptake (Diffusion, Ion exchange, Donnan equilibrium mass flow) and active uptake.

#### UNIT-III :

**Translocation in plants :** Ascent of sap : Path of water, mechanism of ascent of sap, Phloem transport: Movement in Phloem, Direction of movement, source-Sink relationship, phloem loading and phloem unloading, mechanism of phloem transport.

#### UNIT-IV :

**Plant growth regulators:** Discovery, Basic structure. Bio assay, Biosynthesis and Physiological roles of Auxins, Gibberellins, Cytokinins, Absciscic acid, Ethylene.

#### UNIT-V :

**Plant Development :** Physiology of flowering : Photoperiodism: Critical day length and photoperiodic induction, Role of phytochrome in the flower initiation, vernalization. Seed dormancy and germination: Factors causing dormancy of seeds and methods of breaking seed dormancy, factors essential for seed germination. Biochemical changes during seed germination senescence : Types causes, Physiology.

### PRACTICAL

End Sem Practical – 30/3 hrs

#### Expt. -15, Viva Voce- 5 & Lab. Record- 10

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 relation between transpiration and transpiring surface.
4. Calculation of stomatal index and stomatal frequency from both the surfaces of leaves.
5. Cuticular resistance of a xerophytes to transpiration.
6. Microscopic observation of opening and closing of stomata.
7. Measurement of rate of imbibitions in seeds.

#### Suggested Books :

1. Hopkins, W.G. and Huner, A. (2008). Introduction to plant physiology. John Wiley and Sons, U.S.A., 4<sup>th</sup> Edition.
2. Taiz. L. Zeiger, E. Moller, I.M, Murphy, A (2015). Plant physiology and Development. Sinauer Associates Inc. USA, 6<sup>th</sup> Edition.
3. Bajracharya D. (1999), Experiments in plant physiology –A Laboratory Manual. Narosa publishing House, New Delhi.
4. Verma, V. (2009), Text Book of Plant physiology, Ane Books Pvt. Ltd (New Delhi)
5. Salisbury F.B. & Ross C. W. (2005). Plant physiology C.B.S. publishers and distribution Pvt. New Delhi.
6. Srivastava H.N. (2013) Plant physiology. Pradeep publication Jalandhar.
7. Pandey, S.N. and Sinha, B.K. (2015) plant physiology Vikas publishing house Pvt. Ltd. Noida.
8. Jain, V.K. (2014) Fundamental of plant physiology S.Chand & company Pvt. Ltd.

### DSE-5.3 : BIOSTATISTICS

Full Marks – 100  
Mid Sem – 20/1 hr  
End Sem Theory – 50/3 hrs

#### UNIT-I :

**Biostatistics:** Definition, Characteristics, limitation and uses of biostatistics statistical terms, collection and classification of data, sampling and statistical error, methods of presentation of statistical data.

#### UNIT-II :

**Frequency Distribution:** Introduction, types and terms associated with frequency distribution (class, class interval, class limit, class width, class frequency, total frequency, percentage frequency, frequency density,



cumulative frequency). Graphical representation of data : Types and modes of graphical representation of ungrouped and grouped data. (Line diagram, Bar diagram, pie chart, Histogram, Frequency, Polygon, Ogives).

**UNIT-III :**

**Central Tendency :** Measures of central tendency, arithmetic mean, median, mode, its merits and demerits, measures of variation-Dispersion, Range, Mean deviation, standard deviation (merits and demerits), Co-efficient of variation, standard error of mean.

**UNIT-IV :**

**Normal Distribution:** Definition and properties of normal distribution, uses of normal distribution.

Correlation and Regression: Types and methods studying correlation, types and methods of studying regression. Difference between correlation and regression.

**UNIT-V :**

**Statistical inference:** Comparison of means of two small sample (Student's t'-test comparison of means of two large sample chi-square test, Null hypothesis, degrees of freedom, level of significance).

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Calculation of mean, standard deviation and standard error.
2. Calculation of correlation coefficient values
3. Student's t'-test
4. Chi square test
5. Calculation of different measures of central tendency, dispersion skewness and kurtosis.
6. Calculation of simple correlation and regression lines, rank correlation.
7. Construction of frequency distribution table, histogram & frequency polygon.
8. Calculation of multiple and partial correlation coefficients.
9. Tests of significance based on Normal t and  $\chi^2$  distribution.

**Suggested Books :**

1. Biostatistics, Danniel, W.W. 1987, New York, John Wiley Sons.
2. An introduction to Biostatistics, 3<sup>rd</sup> 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.

**DSE-5.4 : PLANT BREEDING**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Plant breeding:** Introduction and objectives. Methods of reproduction in relation to plant breeding.

**Natural mating systems :** Features and genetic consequences (Natural self Pollination, Natural cross-pollination often-cross pollination)

**UNIT-II :**

**Method of crop improvement:** Plant introduction and acclimatization, Selection: Natural selection, artificial selection : Mass selection, pure line selection, clonal selection for self and cross pollinated plants.

**UNIT-III :**

**Hybridization :** Hybridization procedure: Selection of parents, selfing of parents, Hybridization technique (Emasculation, Bagging, crossing, labelling), Harvesting the hybrid seeds and raising F1 generation, Hybridization method of self pollinated crops (Pedigree method, Bulk method, Back cross method) and cross pollinated crops (single cross, three way cross, double cross, Top cross) Advantage and limitations of hybridization.

**UNIT-IV :**

**Inbreeding and heterosis (Hybrid vigour):** Phenotypic consequences of inbreeding : inbreeding depression, Genetic basis of inbreeding, inbreeding for crop improvement. Heterosis : Types, Effects, causes, applications and Genetic basis of heterosis.

**UNIT-V :**

**Crop improvement and breeding :** Role of polyploidy in plant breeding. Importance of plant breeding on modern agriculture, role of Biotechnology in crop improvement.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Study of plant breeders Kit and its component.
2. General procedure of selfing and crossing techniques in plant.
3. Study of reproductive morphology and floral biology and crop plant.
4. Reproduction morphology, floral biding, and cross techniques in cereals (Rice), pulses (Green gram), oil seeds (groundnuts and sun flower).

**Suggested Books :**

1. Singh, B.D. (2005) Plant Breeding : Principles and methods. Kalyani Publishers, 7<sup>th</sup> edition, New Delhi.
2. Choudhari, H.K. (1984) Elementary Principles of plant breeding, Oxford and IBH publishing co, New Delhi.
3. Sharma, J.R. (1994) Principles and practices of plant breeding, Tata McGraw Hill publishing company Ltd. New Delhi.

## **SIXTH SEMESTER**

### **C-6.1 : PLANT METABOLISM**

**Full Marks – 100**  
**Mid Sem – 20/1 hr**  
**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Concept of metabolism and Bioenergetics :** Introduction, anabolism and catabolism, Bioenergetics : Laws of thermodynamic with relation to biological system, enthalpy, entropy, Gibbs free energy, Redox potential.

**UNIT-II :**

**Photosynthesis :** Historical background, photosynthetic pigments, light absorption the red drop and Emerson enhancement effect, photosystems, photosynthetic electron transport and photo phosphorylation, CO<sub>2</sub> reduction: Calvin cycle, C<sub>4</sub> cycle, crassulacean acid metabolism, photorespiration, factors affecting photosynthesis, synthesis.

**UNIT-III :**

**Carbon Oxidation of starch and sucrose :** Respiration: Aerobic & anaerobic Respiratory substrate, RQ Glycolysis, regulation of glycolysis, metabolic fates of pyruvate, TCA cycle, Electron transport and oxidative phosphorylation, Mechanism of ATP synthesis, pentose phosphate pathway.

**UNIT-IV :**

**Lipid metabolism:** Biosynthesis and oxidation of triglyceride : Biosynthesis: Synthesis of fatty acids, glycerol and condensation of fatty acid and glycerol. Oxidation: Hydrolysis of fat, metabolism of glycerol, oxidation of fatty acids: ( $\alpha$ -oxidation,  $\beta$ -Oxidation).

**UNIT-V :**

**Nitrogen metabolism :** Physical and Biological nitrogen fixation: (symbiotic and non-symbiotic); Physiology and biochemistry of nitrogen fixation; Nitrate reduction in plants, Nitrogen assimilation: (Reductive amination and transamination).

## **PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Extraction and estimation 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 to carbon dioxide on the rate of photosynthesis.
5. Separation of photosynthetic pigments by paper chromatography.
6. To demonstrate activity of Nitrate Reductase/Catalase.
7. To study of seed viability.
8. Demonstration of absorption spectrum of photosynthetic pigments.
9. To study the induction of amylase activity in germinating seeds.
10. Test for viability of seeds.
11. Photo reduction of dyes by isolated chloroplast.

**Suggested Books :**

1. Hopkins, W.G. and Huner, A. (2008), introduction to plant physiology, John Wiley and sons. U.S.A. 4<sup>th</sup> edition.
2. Taiz, L. Zeiger, E. Moller, I.M, and Murphy, A (2015). Plant physiology and Development. Sinauer Associates Inc. USA 6<sup>th</sup> edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
4. CONN, Eric. E. Sampf P.K. Bruening G. Doi, R.H. (2007) out line of biochemistry John Wiley and sons Singapur.
5. Pandey, S.N. and Sinha, B.K. (2015) plant physiology Vikas publishing house Pvt. Ltd. Noida.
6. Jain, V.K. (2014) Fundamental of plant physiology S.Chand & company Pvt. Ltd.
7. Srivastava H.N. (2013) Plant physiology. Pradeep publication Jalandhar

## **C-6.2 : PLANT BIOTECHNOLOGY**

**Full Marks – 100**  
**Mid Sem – 20/1 hr**  
**End Sem Theory – 50/3 hrs**

**UNIT-I :**

**Plant Tissue Culture:** Basic techniques of plant tissue culture, composition of culture media (MS, B5 and white's media). Types of culture: Cell culture, suspension culture, single cell isolation and culture. Organogenesis, embryogenesis, Application of tissue culture in agriculture, horticulture and forestry micropropagation.

**UNIT-II :**

**Protoplast culture and somatic hybridisation:** Isolation and culture of protoplast. Somatic hybridization method and application, cybrids. Somaclonal variations. Production of haploid plants: Androgenesis, Gynogenesis.

**UNIT-III :**

**Recombinant DNA technology-I:** Restriction Endonucleases: types of RE, Nomenclature, recognition sequences, cleavage patterns. Cloning vectors: Plasmids (PBR 322 PUC 18/19), Bacteriophage Vector (Lambda phage, phage M-13) cosmids, shuttle vectors. Gene cloning: generation of desired DNA fragments insertion of DNA in to cloning vector.

**UNIT-IV :**

**Recombinant DNA technology-II:** Gene construct: construction of genomic and cDNA libraries, screening DNA libraries to obtain desired gene by genetic selection, complementation, colony hybridization, probes-oligonucleotide, PCR, Agrobacterium-mediated gene transfer method, direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment. Selection of transgenics – selectable marker and reporter genes. DNA finger printing.

**UNIT-V :**

**Applications of Biotechnology:** Pest resistant (Bt-cotton); herbicide resistant plant (Round up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr Tomato, Golden rice); Role of transgenics in bioremediation (Superbug); edible vaccines.

**PRACTICAL**

End Sem Practical – 30/3 hrs

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. (a) Preparation of MS medium.  
(b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of, Datura, Brassica etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer thorough photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Restriction digestion and gel electrophoresis of plasmid DNA.
8. Preparation of artificial seeds (by taking root or shoot apex).

**Suggested Books :**

1. Bhojwani, S.S. and Razdan, M.K. (1996). Plant Tissue Culture: Theory and practice. Elsevier Science Amsterdam, The, Netherlands.
2. Glick B.R. Paternak, J.J. (2003). Molecular Biotechnology-Principles and Applications of recombinant DNA, ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P (2011). The Embryology of Angiosperms. Vikas Publication house Pvt. Ltd. New Delhi. 5<sup>th</sup> edition.
4. Snustad, D.P. and Simmons, M.J. (2010), Principles of Genetics, John Wiley and Sons, U.K. 5<sup>th</sup> edition.
5. Stewart, C.N Jr. (2008) Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
6. Chawla, H.S (2010). Introduction to plant Biotechnology. Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
7. Singhy, B.D. (2010) Biotechnology: Expanding Horizon, Kalyani Publishers New Delhi.
8. Satyanarayan U (2012). Biotechnology. Books and allied (P), Kolkata.
9. De, Kalyan Kumar and introduction to plant tissue culture New Central Book Agency (P) Ltd. Kolkatta.

**DSE-6.3 : INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY**

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

**UNIT-I :**

**Industrial fermentation and Bioreactors :** Introduction and scope of industrial microbiology, Isolation and screening of industrial important microorganisms, Fermentation, Types and process of fermentation. Bioreactor: Design, operation and principles of a typical bioreactor.

**UNIT-II :**

**Microbial production of Aminoacids, Enzymes and Alcoholic Beverages :** Production of amino acids: Lysin, Glutamic acid, Production of enzymes: commercial amylase, pectinase, cellulase and glucose isomerase. Industrial production of Beer and Rum, Microbial production of single cell protein.

**UNIT-III :**

**Microbial production of Antibiotics, Biofertilizers, Biofuels and dairy products:** Antibiotic production: Penicillin, Streptomycin, Vaccines: Types of vaccines, production of Hepatitis, Polio, Mass production of Rhizobium biofertiliser and Azolla. Production of biogas.

**UNIT-IV :**

**Microbes in Air and Water:** Distribution of microbes in air. Isolation and control of indoor air borne micro organism. Microbial component of water. Role of microbes in sewage and domestic waste water treatment. Determination BOD and COD of water samples.

**UNIT-V :**

**Microbes in Soil and Agriculture :** Soil microflora. Mycorrhizae. Bioremediation. Bioleaching. Composting technology. Role of microbes in biogeochemical cycles of nitrogen and carbon.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Principle and functioning of instrument in microbiology laboratory.
2. Isolation of microbes from water, air, soil and sewage
3. Isolation of Rhizobia from Root Nodules.
4. Qualitative and quantitative estimation of microbial enzymes.
5. Study of fermentation process.
6. Determination of BOD and COD.
7. Study of mycorrhizal colonization in plant roots.

**Suggested Books :**

1. Pelzar, M.Jr. Chen. E.C.S. Krieg. N.R. (2010) Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd. Delhi.
2. Tortora, G.J. Funke, B.R. Case. C.L. (2007). Microbiology. Person Benjamin Cummings, San Francisco, U.S.A. 9<sup>th</sup> edition.
3. Sivakumar, P.K. Joe, M.M. and Sukesh, K., (2010) An introduction to industrial Microbiology. S. Chan & Company Ltd., New Delhi.
4. Sharma, K. (2011), Text Book of Microbiology. Ane Books Pvt. Ltd., New Delhi.
5. Sharma, P,D ( 2010). Microbiology. Rastogi publication, Meerut.
6. Dubey R.C. and Maheshwari, D.K., (2013). A Text Book of Microbiology. S. Chand & Company Ltd., New Delhi.
7. Agrawal, A.K. and Parihar Pradeep, (2008) Industrial Microbiology Agrobios India,, Jodhur.

**DSE-6.4 : PROJECT WORK**

**Full Marks – 100**  
**End Sem Project– 100**

To be announced by the HOD.

\*\*\*