

# S.K.M. UNIVERSITY, DUMKA



## COURSES OF STUDY

### M.Sc. Botany

#### Choice Based Credit System (CBCS)

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#### Syllabus for M.Sc. Botany in Choice Based Credit System (CBCS)

The M.Sc. Botany course shall consist of four Semester of six month duration, as detailed in the University Regulation. The course structure will be as follows.

### **Semester-I**

- 1<sup>st</sup> Paper (Theory) : BOT F01- Foundation Course-1
- 2<sup>nd</sup> Paper (Theory) : BOT C02- Core Course-2
- 3<sup>rd</sup> Paper (Theory) : BOT C03- Core Course-3
- 4<sup>th</sup> Paper (Practical) : BOT C04- Core Practical-4 based on 2<sup>nd</sup> and 3<sup>rd</sup> Papers

### **Semester-II**

- 5<sup>th</sup> Paper (Theory) : BOT S05- Skill Development Course-5
- 6<sup>th</sup> Paper (Theory) : BOT C06- Core Course-6
- 7<sup>th</sup> Paper (Theory) : BOT C07- Core Course-7
- 8<sup>th</sup> Paper (Practical) : BOT C08- Core Practical-8 based on 6<sup>th</sup> and 7<sup>th</sup> Papers

### **Semester-III**

- 9<sup>th</sup> Paper (Theory) : BOT A09- Generic Elective (Open Elective) Course-09
- 10<sup>th</sup> Paper (Theory) : BOT C10- Core Course-10
- 11<sup>th</sup> Paper (Theory) : BOT C11- Core Course-11
- 12<sup>th</sup> Paper (Practical) : BOT C12- Core Practical-12 based on 10<sup>th</sup> and 11<sup>th</sup> Papers

### **Semester-IV**

#### **Elective A: Microbiology and Plant Pathology**

- 13<sup>th</sup> Paper (Theory) : BOT E13- Elective Theory-I
- 14<sup>th</sup> Paper (Theory) : BOT E14- Elective Theory-II
- 15<sup>th</sup> Paper (Practical) : BOT E15- Practical based on 13<sup>th</sup> and 14<sup>th</sup> Papers
- 16<sup>th</sup> Paper (Dissertation) : BOT E16- Dissertation/ Project work based on Elective Papers

### **Semester-IV**

#### **Elective B: Cytogenetics and Plant Breeding**

- 13<sup>th</sup> Paper (Theory) : BOT E13- Elective Theory-I
- 14<sup>th</sup> Paper (Theory) : BOT E14- Elective Theory-II
- 15<sup>th</sup> Paper (Practical) : BOT E15- Practical based on 13<sup>th</sup> and 14<sup>th</sup> Papers
- 16<sup>th</sup> Paper (Dissertation) : BOT E16- Dissertation/ Project work based on Elective Papers

### **Semester-IV**

#### **Elective C: Biochemistry and Plant Physiology**

- 13<sup>th</sup> Paper (Theory) : BOT E13- Elective Theory-I
- 14<sup>th</sup> Paper (Theory) : BOT E14- Elective Theory-II
- 15<sup>th</sup> Paper (Practical) : BOT E15- Practical based on 13<sup>th</sup> and 14<sup>th</sup> Papers
- 16<sup>th</sup> Paper (Dissertation) : BOT E16- Dissertation/ Project work based on Elective Papers

### **Semester-IV**

#### **Elective D: Environmental Biology**

- 13<sup>th</sup> Paper (Theory) : BOT E13- Elective Theory-I
- 14<sup>th</sup> Paper (Theory) : BOT E14- Elective Theory-II
- 15<sup>th</sup> Paper (Practical) : BOT E15- Practical based on 13<sup>th</sup> and 14<sup>th</sup> Papers
- 16<sup>th</sup> Paper (Dissertation) : BOT E16- Dissertation/ Project work based on Elective Papers

**Distribution of Marks**

<b>Sem</b>	<b>Paper No</b>	<b>Paper</b>	<b>End sem marks</b>	<b>Mid sessional test marks</b>	<b>Seminar marks</b>	<b>Attendance marks</b>	<b>Total</b>	
<b>I</b>	<b>I</b>	<b>BOT-F01(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>II</b>	<b>BOT-C02(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>III</b>	<b>BOT-C03(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>IV</b>	<b>BOT-C04(Practical)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
<b>II</b>	<b>V</b>	<b>BOT-S05(Theory)</b>	<b>35</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>65</b>	<b>100</b>
		<b>BOT-S05(Practical)</b>	<b>35</b>					
	<b>VI</b>	<b>BOT-C06(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>VII</b>	<b>BOT-C07(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>VIII</b>	<b>BOT-C08(Practical)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
<b>III</b>	<b>IX</b>	<b>BOT-A09(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>X</b>	<b>BOT-C10(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>XI</b>	<b>BOT-C11(Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>XII</b>	<b>BOT-C12(Practical)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
<b>IV</b>	<b>XIII</b>	<b>BOT-E13(Elective Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>XIV</b>	<b>BOT-E14(Elective Theory)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>XV</b>	<b>BOT-E15(Practical)</b>	<b>70</b>	<b>20</b>	<b>05</b>	<b>05</b>	<b>100</b>	
	<b>XVI</b>	<b>BOT-E16(Dissertation)</b>					<b>100</b>	

**Semester- I**

**Paper-I**  
**BOT-F01 (Foundation Course-1)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Viruses:** General characters and classification.

**Unit-2: Bacteria:** General characters and economic importance.

**Unit-3: Fungi:** Salient feature, economic importance and classification (Aniswarth 1973; Alexopoulos & Mims 1979).

**Unit-4: Algae:** Salient feature, economic importance and classification (Fritsch 1935; Round 195).

**Unit-5: Bryophytes:** Salient feature and classification (Cavers 1911; Smith 1955 & Parihar 195).

**Unit-6: Pteridophytes:** Salient feature and classification (Smith 1955; Sporne 1975).

**Unit-7: Gymnosperms:** Salient feature and classification (Arnold 1984; Sporne 1965).

**Unit-8: System of plant classification:** Bentham and Hooker; Hutchinson; Takhatjan system with their merits and demerits.

**Unit-9: Concept of taxonomical hierarchy:** Species/genus/family/and other categories; species concept.

**Unit-10: International code of botanical nomenclature (ICBN):** history of ICBN, principles, rules, type method, author citation, valid and effective publication, principle of priority.

**Unit-11: Herbarium:** important herbaria and botanical gardens of India and the world; documentation; flora, keys.

**Suggested readings:**

1. Alexopoulos C.J , Mims C.W. and Blackwel M.I 1996. Introductory Mycology. John Wiley and Sons Inc.
2. Kumar H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
3. Mehrotra R.S and Aneja R.S 1998. An introduction to Mycology. New Age Intermediate Press.
4. Vashista B.R & A.K Sinha 2005. Botany for degree students – Bryophyta, S.Chands Publication.
5. Pandey S.N. A Text-book of Botany Volume I, Vikas Publications.
6. Sporne K.R. 1991. The Morphology of Pteridophytes. B.I Publishing Pvt. Ltd. Bombay.
7. Chamberlain C.J 1934. Gymnosperms-Structure and Evolution, Chicago.
8. Lawrence G.H.M 1955. An Introduction to Plant Taxonomy N.Y.
9. Pandey B.P 1997. Taxonomy of Angiosperms. S.Chand Publication.

## **BOT-C02 (Microbiology, Mycology, Phycology and Plant Pathology)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Bacteria:** Reproduction; binary fission, conjugation, transformation and transduction.

**Unit-2: Cyanobacteria:** characteristic features, range of vegetative structure, ultra structure of a typical cyanobacterial cell, reproduction.

**Unit-3: Virus:** Characteristics and ultra structure of virions, isolation and purification of viruses, chemical nature, replication, transmission of viruses and economic importance.

**Unit-4: Mycoplasma:** structure, life cycle and significance.

**Unit-5: Fungi:** Heterothallism and sex hormones, fungi as bio control agents.

**Unit-6:** Structure, life cycle and phylogeny of the following orders;

- i. Chytridiales
- ii. Peronosporales
- iii. Erysiphales
- iv. Uredinales
- v. Moniliales

**Unit-7: Mycotoxins:** general account, types, effects and control measures.

**Unit-8: Mycorrhizae:** general account, their role and application in agriculture and forestry.

**Unit-9: Algae:** Role of pigments, reserve food and flagella in the classification, range of thallus structure in algae, evolution of sex in algae,

**Unit-10: Structure, life cycle and phylogeny of the following orders;**

- i. Volvocales
- ii. Chaetophorales
- iii. Charales
- iv. Fucales and
- v. Nematinales

**Unit-11: Brief account of the following;**

- i. Algal bloom.
- ii. Algae as indicator of water pollution.
- iii. Planktonic, benthic, parasitic and terrestrial algae.
- iv. Desmids.
- v. Diatoms.
- vi. Dinoflagellates.

**Unit-12: Symptoms, etiology and control measures of the following diseases;**

- i. Bacterial leaf blight of paddy.
- ii. Leaf curl of papaya.
- iii. Little leaf of brinjal.
- iv. Rust of linseed.
- v. Tikka disease of groundnut.

**Suggested readings:**

1. Alexopoulos C.J , Mims C.W. and Blackwel M.I 1996. Introductory Mycology. John Wiley and Sons Inc.
2. Kumar H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
3. Mehrotra R.S and Aneja R.S 1998. An introduction to Mycology. New Age Intermediate Press.
4. Rangaswamy G. and Mahadevan A. 1999. Diseases of crop plants in India (Fourth Edition) Prentice Hall of India Pvt. Ltd. New Delhi.
5. Dubey, R.C. & Maheswari, D.K. A Text Book of Microbiology, 2005, S.Chand & Company.
6. Biswas, S.B. & Biswas, A. An Introduction to Viruses (4th ed.), 1996, Vikas Publishing House.
7. Power, C.B. & Dagimawata, H.F. General Microbiology, Vol. I&II, Himalaya Publishing House.
8. Sale, A.J. Fundamental Principles of Microbiology, Latest Ed., Tata McGraw Hill.
9. Kamat M.N 1959. Hand Book of Mycology, Prakash Publication.
10. Vashista B.R & A.K Sinha 2005. Botany for degree students – Fungi, S.Chands Publication.
11. Ainsnorth G.C 1973. The Fungi Vol IV A, IV B Academic Press.
12. Bessey 1950. Morphology and Taxonomy of fungi. The Blakistan Co.
13. Morries I 1986. An Introduction to the Algae. Cambridge University Press, U.K.
14. Fritsch F.E (1945). The structure and reproduction of the algae Volume I and II, Cambridge University Press.

**Semester- I**  
**Paper-III (Core Course-3)**  
**BOT-C03 (Bryophyta, Pteridophyta, Gymnosperms and Angiosperms)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1:** Structure, reproduction, affinities and evolutionary trends of the following orders;

- i. Sphaerocarpaceae
- ii. Marchantiales
- iii. Anthocerotales
- iv. Sphagnales

**Unit-2: Bryophytes:** Evolutionary trend of progressive sterilization of sporogenous tissues and photosynthetic tissues. Bryophytes as site indicators, responses of bryophytes to environmental pollution, initial colonization and succession.

**Unit-3:** Structure, reproduction, affinities and evolutionary trend of the following order;

- i. Psilophytales
- ii. Lepidodendrales
- iii. Isoetales
- iv. Ophioglossales
- v. Osmundales

**Unit-4: Pteridophytes:** Telome theory, stelar organization and evolution of stele, heterospory and seed habit

**Unit-5:** Vegetative morphology and reproductive biology, affinities and evolutionary trends of the following orders;

- i. Pentoxylales
- ii. Corditales
- iii. Ginkgoales
- iv. Taxales and
- v. Gnetales (emphasis on angiospermic features)

**Unit-6: Gymnosperms:** Distribution of living gymnosperms in India, evolution of female gametophytes and embryogeny in gymnosperms, fossil gymnosperm flora of Jharkhand and economic importance of gymnosperms.

**Unit-7: Phytogeography:** Concept, endemism, hotspots, plant exploration and plant introduction.

**Unit-8: Recent trends in plant taxonomy:** Numerical taxonomy, chemotaxonomy and cytotaxonomy.

**Unit-9: Angiosperms:** Diagnostic characteristics, systematic phylogeny and economic importance of angiospermic families; Magnoliaceae, Apocynaceae, Asclepiadaceae,

Scrophlariaceae, Acanthaceae, Dipterocarpaceae, Lamiaceae, Verbenaceae, Euphorbiaceae, Rubiaceae, Orchidaceae, Cyperaceae and Poaceae.

**Suggested readings:**

1. Smith, G.M. Cryptogomic Botany. Vol.II

2. Parihar, N.S.: Bryophyta.
3. Parihar, N.S.1976: Biology and Morphology of Pteridophytes.
4. Sporne, K.R. Pteridophyta .
5. Rashid: Introduction to Pteridophyta.
6. Cavers, F. Inter-relations of Bryophytes.
7. Lawrence: Taxonomy of Vascular Plants.
8. Chamberlain, C.J. Gymnosperms: Structure and evolution.
9. Sporne K. R: The Morphology of Gymnosperms.
10. Vashistha, P.C. 1978: Gymnosperms.
11. Sivarajan, V.V. (Ed. Robson). Introduction to Principles of Plant Taxonomy.
12. Heywood, V.H. Plant Taxonomy.
13. Naik, V.N. Taxonomy of Angiosperms.

**Semester- I**  
**Paper-IV**  
**BOT-C04 (Core Practical Course-4)**  
**Based on II<sup>nd</sup> and III<sup>rd</sup> Papers**

**Full Marks-100 (End-70+ Int-30)**

**A. Microbiology;**

1. Preparation of PDAM/CDAM.



2. Staining and identification of bacteria.
3. Calibration of microscope and spore measurement.

**B. Plant Pathology;**

1. Preparation of fungicides and test of their efficacy-bordeaux/burgundy mixture.
2. Study of working and use of pathological instruments; autoclave/centrifuge/thermostat.
3. Isolation/sterilization/inoculation and pure culture of fungi.
4. Study of disease prescribed in your syllabus.

**C. Phycology;**

1. Preparation of temporary slides, enumeration of salient features and identification of materials of orders described in your syllabus.

**D. Mycology;**

1. Preparation of temporary slides, enumeration of salient features and identification of materials of orders described in your syllabus.

**E. Bryophyta;**

1. Preparation of temporary slides, enumeration of salient features and identification of materials of orders described in your syllabus.

**F. Pteridophyta;**

1. Preparation of temporary slides, enumeration of salient features and identification of materials of orders described in your syllabus.

**G. Gymnosperms;**

1. Preparation of temporary slides, enumeration of salient features and identification of materials of orders described in your syllabus.

**H. Angiosperms;**

1. Description of morphology, floral characters and identification of the family given in your syllabus and also give floral formula and floral diagrams.

**Distribution of marks:**

Experiments	:	30 marks	
Spotting	05 x 2	:	10 marks
Records/Models/Charts/Herbarium/Tour Report	:	15marks	
Viva Voce	:	15 marks	

**Semester- II  
Paper-V**

(There are three options in this paper, out of which only one option has to taken by the students)

**BOT-S05- Skill Development Course-5 (Biofertilizers)**

**Full Marks-100 (Theory-int30+end35= 65 & Practical-35)**

**Unit-1: General account about the microbes used as: biofertilizer; Rhizobium; isolation, identification, mass multiplication & actinorrhizal symbiosis.**

**Unit-2: Azospirillum:** isolation and mass multiplication- carrier based inoculants, associative effect of different microorganism, Azotobacter, characteristics- crop response to Azotobacter inoculums, maintenance and mass multiplication.

**Unit-3: Cyanobacteria** (blue green algae): Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azollae in rice cultivation.

**Unit-4: Mycorrhizal association,** types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition growth and yield- colonization of VAM- isolation and inoculums production of VAM, and its influence on growth and yield of crop plants.

**Unit-5: Organic farming,** green manuring and organic fertilizers, recycling of bio degradable municipal, agriculture and Industrial wastes- bio compost making methods, types and method of vermicomposting- field application.

**Practical: -**

1. Isolation, staining, identification, inoculation and mass multiplication of Rhizobium / Azospirillum / Azotobacter / Cyanobacteria (blue green algae).
2. Preparation of temporary slide of different parts of Azolla and its association with Anabeana azolla and factors affecting growth and nitrogen fixation in rice.
3. Study of mycorrhizal association, types of mycorrhizal association, colonization of VAM- isolation and inoculums production of VAM and its influence on growth and yield of crop plants.
4. Spotting
5. Viva- voce
6. Records/projects/ charts/ models etc

**Suggested readings:**

1. Bergerson FJ. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley and Sons.
2. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage-
3. A Source Book-cum-glossary. FDCO, New Delhi. Subba Rao, N.S. Biofertilizers in Agriculture and Forestry. 1993. Oxford and IBH. Publ. Co., New Delhi.
4. M.R., P. Bhattacharyya and Beena Srivastava, Biofertilizer Technology, Marketing and usage- A source Book -cum-glossary 1995. Motsara, I. FDCO, New Delhi.
5. Biofertilizers in Agriculture and Forestry 1993. N.S. Subba Rao Oxford and IBH Publ. Co., New Delhi.

**BOT-S05- Skill Development Course-5 (Plant diversity & Human welfare)**

**Full Marks-100 (Theory-int30+end35= 65 & Practical-35)**

1. **Unit-1: Plant diversity and its scope-** Genetic diversity, species diversity, plant diversity at the ecosystem. Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of biodiversity; ethical and aesthetic value. Precautionary principle, methodologies for valuation, uses of plants and uses of microbes.
2. **Unit-2: Loss of biodiversity;** Loss of genetic diversity, loss of species diversity, loss of ecosystem diversity, loss of agrobiodiversity, projected scenario for biodiversity loss, management of plant biodiversity; organization associated with biodiversity management ; methodology for execution-

IUCN, UNEP, UNESCO, WWF, NBPGR; biodiversity legislation and conservation, biodiversity information management and communication.

3. **Unit-3: Conservation of biodiversity;** Conservation of genetic diversity, species diversity and ecosystem diversity, in situ & ex situ conservation, social approaches to conservation, biodiversity awareness programmes, sustainable development.
4. **Unit-4: Role of plants in relation to human welfare;** importance of forestry their utilization and commercial aspects, avenue trees, ornamental plants of India, alcoholic beverages through ages, fruits and nuts, important fruit crops their commercial importance, wood and its uses.

#### **Practical:**

1. Study of Genetic diversity. Species diversity, ecosystem diversity, Agro biodiversity and cultivated plant taxa, wild taxa, Values and uses of Biodiversity; Ethical and aesthetic values. Methodologies for valuation, Uses of plants, Uses of microbes.
2. Study of loss of genetic diversity, species diversity, ecosystem diversity, agro biodiversity, Projected scenario for bio diversity loss, Methodology for execution- IUCN, UNEP, UNESCO, WWF, NBPGR, Biodiversity legislation and conservations, Biodiversity information management and communication.
3. Study of conservation of genetic diversity, species diversity and ecosystem diversity, *In situ, ex-situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, sustainable development. Importance of forestry their utilization and commercial aspects preparation of reports on avenue trees, ornamental plants of India, fruits and nuts; wood and its uses.
4. Spotting.
5. Viva- voce.
6. Records/projects/ charts/ models etc.

#### **Suggested readings:**

1. Gadgil, M. et. al. A Methodology Manual for Documenting People's Priorities for Biodiversity and Conservation. Shrustiygyaan.
2. Watt, K.E.F. (1973). Principles of Environmental Science, McGraw – Hill Book Company
3. Santra, S. C. (2001). Environment Science, New Central Book Agency (P) Ltd.
4. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. Science Publication.
5. Primack, R. 2006. Essentials of Conservation Biology. Sinauer Associates, Inc., USA.
6. Hambler, C. 2004. Conservation. Cambridge University Press.
7. Agarwal, K. C. (1989), Environmental Biology, Agrobotanical Publishers

### **BOT-S05- Skill Development Course-5 (Mushroom Cultivation)**

**Full Marks-100 (Theory-int30+end35= 65 & Practical-35)**

1. **Unit-1: Introduction,** history, nutritional and medicinal value of edible mushrooms; poisonous mushrooms. Types of edible mushrooms available in India; *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agricus bisporus*.
2. **Unit-2: Cultivation technology;** Infrastructure, substrates (locally available) polythene bag, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (thatched house) water sprayer, tray, small polythene bag, pure culture; medium, sterilization, preparation of spawn, multiplication, mushroom bed preparation- paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation- low cost technology, composting technology in mushroom production..

3. **Unit-3: Storage and nutrition;** short term storage (refrigeration upto 24 hours), long term storage (canning, pickles, papads), drying, storage in salt solution. Nutrition; proteins, amino acids, mineral elements nutrition- carbohydrates, crude fibre content-vitamins.
4. **Unit-4: Food preparation;** types of foods prepared from mushroom. Research centres- National level and regional level. Cost benefit ratio- Marketing in India and abroad, export value.

#### **Practical:**

1. Collection, identification, characterization and types of edible and poisonous mushrooms like *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus* etc.
2. Study of tools and techniques like- inoculation hook, inoculation loop, low cost stove, sieve, culture rack, mushroom unit (Thatched house) water sprayer, tray, , pure culture; medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation – paddy straw, sugarcane trash, maize straw, banana leaves. Composting technology in mushroom production.
3. Methods of short term storage (Refrigeration – up to 24 hours). Long term storage (Canning, pickles, papads), drying, storage in salt solutions analysis of proteins- amino acids, mineral elements carbohydrates, crude fibre content and vitamins. Methods of preparations of foods prepared from mushroom, evaluation of Cost benefit ratio, marketing in India.
4. Spotting
5. Viva- voce
6. Records/projects/ charts/ models etc

#### **Suggested readings:**

1. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore.
2. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd., New Delhi.
3. Bahl, N. 1988. Handbook on mushrooms. Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.

## **Semester- II** **Paper-VI (Core Course-6)** **BOT-C06 (Cell biology, Molecular biology and Genetics)**

#### **Full Marks-100 (End-70+ Int-30)**

1. **Unit-1:** Structure and function of microbodies, golgi apparatus, lysosomes and endoplasmic reticulum; cytoskeleton- nature of cytoskeleton, intermediate filaments, microtubules, cilia and centrioles.
2. **Unit-2: Cell cycle:** introduction, phases, cell cycle control.
3. **Unit-3:** Structure of chromatin and chromosomes; packaging of DNA; interrupted genes; gene families; unique and repetitive DNA; heterochromatin and euchromatin; banding patterns; transposable elements.
4. **Unit-4: Chromosome:** origin, structure and significance.
5. **Unit-5:** Nuclear DNA content; C-value paradox; Cot-curve and its significance; restriction mapping- concept and technique.

6. **Unit-6:** RNA synthesis and processing: Transcription factor and machinery, formation of initiation complex, transcription activation repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, RNA polyadenylation, structure and functions of different types of RNA.
7. **Unit-7:** Regulation of gene expression in prokaryotes and eukaryotes.
8. **Unit-8:** DNA replication, repair and recombination: unit of replication, enzymes involved replication origin and replication fork, extra chromosomal replicons, DNA damage and repair mechanisms.
9. **Unit-9:** Extra chromosomal inheritance; inheritance of mitochondria and chloroplast genes; maternal inheritance.
10. **Unit-10:** Quantitative genetics: polygenic inheritance (characteristic, multiple factor hypothesis, seed colour in wheat, corolla tobacco); heritability and its measurements; QTL-mapping.
11. **Unit-11:** Structural alternation in chromosomes: origin, meiosis and breeding behaviour of duplication, deficiency, inversion translocation. Numerical alternations in chromosomes; origin, occurrence, production and meiosis of haploids, aneuploids, euploids; origin and production of autopolyploids; genome constitution and analysis of allopolyploids; evolution of major plants; induction and characterization of trisomics and monosomics.
12. **Unit-12:** Correlation; types and methods of correlation, simple regression equation, fitting predication, similarities, dissimilarities of correlation and regression. Measures of central tendency and dispersal; probability distributions ( Bin Poisson and normal); sampling distribution; difference between parametric and non- parametric statistics; confidence in errors; levels of significance; regression and correlation. Statistical inference- hypothesis; simple hypothesis, student 't' test, square test.

**Suggested readings:**

1. Sundara Rajan , S. 2003. Introduction to Cell Biology. Vikas Publishing House Pvt. Ltd., New Delhi.
2. Verma, P.S. and Agarwal, V.K. 2004. Cell biology, Genetics, Molecular Biology, Evolution and Ecology.
3. S.Chand & Company Ltd. New Delhi. 5. Nair, P.K.G. and Prabhakar Achari, K. 1999. A Text Book of Cell Biology. Konark Publishers Pvt. Ltd., Delhi
4. Arora P.N. Malhan P.K. 1996. Biostatistics, Delhi : Himalaya Publishing House.
5. Gupta, S.P.1992. Statistical Methods, New Delhi: Sultan Chand, 1992.
6. Gupta C.B.1992. An Introduction to statistical methods Vikas Publishers, New Delhi; David Freifelder, 1996, Molecular Biology, 4th Reprint., Narosa Publishing House, New Delhi, India.
7. H.D. Kumar, 1993, Molecular Biology & Biotechnology, Vikas publishing house Pvt. Ltd., New Delhi.
8. S.C. Rastogi, V.N. Sharma, Biology & Biotechnology, Vikas Publishing House Pvt. Ltd., New Delhi.

**Semester- II**  
**Paper-VII (Core Course-7)**  
**BOT-C07 (Ecology and Environmental Biology)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Ecosystem**

- a) Modern concept, structural components, trophic structure, food chain, food web and ecological pyramids.
- b) Structure and function of some Indian ecosystem; terrestrial ecosystem (forest and grassland) and aquatic ecosystem (fresh water and marine).
- c) Ecological energetic; concept and mode of energy flow in aquatic ecosystem.
- d) Productivity; types and methods of primary productivity and its measurement.

**Unit-2: Community**

- a) Structure; Analytic and synthetic characters with emphasis on I.V.I and species diversity index (H).
- b) Ecological niche, edges and ecotones.
- c) Ecological succession; Types and process of succession; hydrosere and xerosere, concept of climax.

**Unit-3: Plant geography**

- a) Biomes of world.
- b) Major vegetation types of India with special reference to Jharkhand.

**Unit-4: Plant biodiversity;** Concept, status in India, utilization and concerns.

**Unit-5: Strategies for plant conservation:**

- a) *In situ* conservation: Protected areas in India- sanctuaries, national parks, biosphere reserves, wetlands, mangroves, sacred groves and coral reefs for conservation of wild biodiversity.
- b) *Ex situ* conservation: Botanical gardens, gene banks, cryobanks.

**Unit-6: Air pollution:** sources, effects and control with special reference to global warming, green house effect, ozone depletion and acid rain.

**Unit-7: Water pollution:** sources, effects and control with emphasis an eutrophication and biological magnification.

- a) Role of biotechnology in pollution control.

**Unit-8:** Application of biotechnology in solid waste management.

**Unit-9: Forest management**

- a) Forest; forest types found in India, Deforestation, Chipko movement, Social forestry and Biosphere reserves.
- b) National forest policy and forest laws.

**Unit-10: Brief account of the following**

- a) Bioindicators
- b) Convention on Biological Diversity (CBD)
- c) Kyoto protocol and carbon trading
- d) IUCN (International Union for Conservation of Nature)
- e) Gene campaign
- f) Rare, threatened and endangered flora of India.

**Suggested readings:**

1. Schulze, E.D., Beck, E. And K. Muller-Hohenstein. 2005. Plant Ecology. Springer. New York.
2. Odum E.P. Gray, W. Barrelet 2004. Fundamentals of Ecology. 15th edition. Thomas Asia Pvt. Ltd.
3. Chawla, S. 2011. A text book of Environment & Ecology. Tata Mc Graw-Hill, New Delhi.
4. Chapman, J.L. and Reiss, M.J. 1999. Ecology; Principles and Applications. II Ed. Cambridge University Press. New York.
5. Smith, R.L. 1996. Ecology and Field Ecology, Harper Collins, New York.
6. Misra, R. 1968. Ecology work book, Oxford & IBH, New Delhi.

**Semester- II****Paper-VIII****BOT-C08 (Core Practical Course-8)****Full Marks-100 (End-70+ Int-30)**

1. Plant anatomy related to ecological adaptations.
2. To determine frequency/density/abundance in a grassland vegetation.
3. Study of temperature, pH and transparency of dissolved. O<sub>2</sub>/ free CO<sub>2</sub> from aquatic ecosystem.
4. Isolation of algae and bacteria from aquatic ecosystem.
5. Productivity study by Light and Dark bottle.
6. Cytological techniques; Pre-fixation, fixation, mounting, squashing of root tips for the study of various stages of mitosis.
7. Study of different stages of meiosis.
8. Problems based on mendelian ratios and their modifications, statistical analysis and genetic explanation.

**Distribution of marks:**

Experiments	:	30 marks	
Spotting	05 x 2	:	10 marks
Records/Models/Charts/Herbarium/Tour Report	:	15marks	
Viva Voce	:	15 marks	

**Semester- III  
Paper-IX**

(There are four options in this paper, out of which only one option has to taken by the students)

**BOT-A09- Generic (Open) Elective Course-9 (Industrial and Environmental Microbiology)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Scope of microbes:** In industry and environment.

**Unit-2: Bioreactors/ fermenters and fermentation processes:** solid state and liquid state (stationary and submerged) fermentations; batch and continuous fermentations. Components of a typical bioreactor, types of bioreactors-laboratory, pilot scale and production fermenters: constantly stirred tank fermenters, tower fermenter, fixed bed and fluidized bed bioreactors and air lift fermenters.

**Unit-3:** A visit to any educational institute/ industry to see an industrial fermenter and other downstream processing operations.

**Unit-4:Microbial production of industrial products:** microorganisms involved, media ,fermentation conditions, downstream processing and uses: filtration , centrifugation, cell

disruption, solvent extraction, precipitation and ultra filtration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of enzyme; amylase or lipase activity, organic acid (citric acid or glutamic acid), alcohol (ethanol) and antibiotic (penicillin).

**Unit-5: Microbial enzymes of industrial interest and enzyme immobilization:** microorganism for industrial applications and hands on screening microorganisms for casein hydrolysis: starch hydrolysis: cellulose hydrolysis, methods of immobilization, advantage and applications of immobilization, large scale application of immobilized enzymes (glucose isomerase and penicillin acylase).

**Unit-6: Microbes and quality of environment:** distribution of microbes in air: isolation of microorganisms from soil, air and water.

**Suggested readings:**

1. Whitaker and Stanbury. Principles of Fermentation Technology.
2. N S Subba Rao. Soil Microbiology. Oxford and IBH.
3. Casida. Industrial Microbiology. Tata McGraw Hill.
4. Atlas and Bartha. Microbial Ecology. Pearson.
5. M J Pelczar, E C S Chan and N R Krieg. Microbiology. Tata McGrawHill.
6. T D Brock. Biology of Microorganisms. Prentice Hall.
7. R C Dubey and D K Maheshwari. A Textbook of Microbiology. S.Chand.

**BOT-A09- Generic (Open) Elective Course-9 (Bioinformatics)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Introduction to Bioinformatics:** introduction, branches of bioinformatics, aim, scope and research areas of bioinformatics.

**Unit-2: Databases in bioinformatics:** introduction, biological databases, classification, format of biological databases, biological databases retrieval system.

**Unit-3: Biological sequence databases:** National Centre for Biotechnology Information (NCBI): tools and databases of NCBI, database retrieval tool, and sequence submission to NCBI, basic local alignment search tool (BLAST), nucleotide database, protein database, gene expression data base.

**Unit-4: EMBL Nucleotide Sequence Database (EMBL-Bank):** introduction, sequence, retrieval sequence submission to EMBL, sequence analysis tools.

**Unit-5: Swiss-Prot:** introduction and salient features.

**Unit-6: Sequence Alignments:** introduction, concept of alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, scoring matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).



**Unit-7: Molecular Phylogeny:** methods of phylogeny, software for phylogenetic analysis, consistency of molecular phylogenetic prediction.

**Suggested readings:**

1. Sharma Vinay. A Text book of Bioinformatics, Rastogi Publication.
2. Lesk, M. Introduction to Bioinformatics, 1st edition, Oxford University Press.
3. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug. PHI learning, New Delhi.

**BOT-A09- Generic (Open) Elective Course-9 (Crop Improvement)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Plant breeding:** Introduction and objectives. Breeding system; modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding. Introduction, Center of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods; For self pollinated, cross pollinated and vegetatively propagated plants;

**Unit-2: Hybridization:** For self, cross and vegetatively propagated plants- procedure, advantages and limitations. Role of mutations, polyploidy; Distant hybridization.

**Unit-3: Role of biotechnology in crop improvement.**

**Unit-4: Tissue culture and genetic transformation:** Micropropagation; Introduction, techniques, Micropropagation of elite plants, advantages, Micropropagation research in India.

**Unit-5: Somatic hybridization:** Introduction, techniques of somatic hybridization, selection of fused protoplast and significance; Cybrids- techniques advantages and uses. Genetic transformation of plants; Vector mediated transformation.

**Unit-6: Agrobacterium-:** the natural genetic engineer; methods of direct gene transfer in plants.

**Suggested readings:**

1. Satbir Singh Gosal and Shabir Hussain Wani: Biotechnologies of Crop Improvement, Volume 3: Genomic Approaches, Springer.
2. B.D. Singh: Plant breeding principles and methods. Paperback pub.
3. Norman Simmonds & J. Smartt: Principles of Crop Improvement 2nd Edition, Wiley-Blackwell.

**BOT-A09- Generic (Open) Elective Course-9 (Biodiversity-Microbes, Algae, Fungi and Archegoniate)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Microbes:** Viruses; general structure, Nature & economic importance, TMV. Bacteria; general characteristics and cell structure; economic importance.

**Unit-2: Algae and Fungi:** Algae; general characters, range of thallus organization, reproduction and economic importance. Fungi; General characters, economic importance of fungi.

**Unit-3: Introduction to Archegoniate:** Unifying features of archigoniates, Transition to land habit, alternation of generations.

**Unit-4: Bryophytes:** General characters, range of thallus organization, photosynthetic tissues and economic importance.

**Unit-5: Pteridophytes:** General characters, classification, heterospory and seed habit, stellar evolution and economic importance.

**Unit-6: Gymnosperms:** General characters: Ecology and economic importance.

**Suggested readings:**

1. Kumar H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
2. Mehrotra R.S and Aneja R.S 1998. An introduction to Mycology. New Age Intermediate Press.
3. Vashista B.R & A.K Sinha 2005. Botany for degree students – Bryophyta, S.Chands Publication.
4. Sporne K.R. 1991. The Morphology of Pteridophytes. B.I Publishing Pvt. Ltd. Bombay.
5. Chamberlain C.J 1934. Gymnosperms-Structure and Evolution, Chicago.

**Semester- III**  
**Paper-X (Core Course-10)**  
**BOT-C10 (Plant Physiology and Biochemistry)**

**Full Marks-100 (End-70+ Int-30)**

**Unit-1: Plant-Water Relation**

1. Water and mineral relation of plants; water potential and membrane transport system.
2. Absorption of water.
3. Role of macro and micronutrients; mineral salt absorption.
4. Uptake, transport and translocation of water, solutes and macromolecules from soil, through cells, across membranes through xylem and phloem; transpiration; mechanism of loading and unloading of photoassmilates.
5. Mechanism of stomatal opening and closing.

**Unit-2: Biochemistry**

6. Enzymes; Nomenclature and classification, nature and properties, coenzymes and prosthetic groups, enzyme kinetics; mechanism and mode of enzyme action, isoenzymes, allosteric enzymes ribozyme.
7. Classification , biochemistry and function of;
  - a) Carbohydrates
  - b) Amino acids
  - c) Proteins (including secondary, tertiary and quaternary structure, domains)
  - d) Vitamins

8. Secondary metabolites; biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

### **Unit-3: Metabolism**

9. Photosynthesis; Light harvesting complexes, mechanisms of electron transport; photo protective mechanisms; CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub> and CAM pathways; photorespiration.
10. Respiration; Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photo respiratory pathway.
11. Lipid metabolism; biosynthesis of fatty acids, oxidation of fats, triglycerides, Glyoxylate cycle,  $\alpha$  and  $\beta$  oxidation of lipids.
12. Biological Nitrogen fixation.
13. Protein synthesis and processing; Ribosome, formation of initiation complex, initiation factors. elongation and elongation factors, termination, genetic code, aminoacylation of t-RNA aminoacyl t-RNA synthetase, translational proof-reading, translational inhibitors.

### **Unit-4: Growth and Development**

14. Phytohormones; chemical nature, biosynthesis, mode of action and role of Auxins, Gibberellins, Cytokinins, ABA and Ethylene.
15. Sensory photobiology; Phytochromes, Cryptochromes; Photoperiodism; Vernalization and Biological clocks.
16. Stress physiology; responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanism and resistance to biotic stress and tolerance to abiotic stress.
17. Senescence and Programmed Cell Death (PCD).

### **Suggested readings:**

1. H. S. Srivastava , N. Shankar., Plant Physiology and Biochemistry, Rastogi Publications.
2. S K Verma , Mohit Verma., A Textbook of Plant Physiology, Biochemistry and Biotechnology, S Chand; Fourth edition.
3. S.N. Pandey & B.K. Sinha., Plant Physiology, Vikas Publishing House Pvt Ltd.
4. Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists Maryland, USA.
5. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
6. Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA.
7. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA. ]
8. Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
9. Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
10. Leninger A.C 1987. Principles of Biochemistry, CBS Publishers and Distributors (Indian Reprint).

**Semester- III**  
**Paper-XI (Core Course-11)**  
**BOT-C11 (Anatomy, Embryology and Genetic Engineering)**

**Full Marks-100 (End-70+ Int-30)**

**Time- 03 Hrs**

**Unit-1: Anatomy**

1. Organization of Shoot Apical meristem (SAM); Leaf development and differentiation; Organization of Root Apical Meristem (RAM).
2. Stomata; morphology, types and ontogeny.
3. Periderm: Formation and function; lenticels, abscission and healing of wounds.
4. Nodal anatomy and its significance.
5. Leaf and wood anatomy in ecological perspective.

**Unit-2: Embryology**

6. Male sterility: self and interspecific incompatibility; double fertilization.
7. Endosperm; types and development, functions, cytology and morphogenetic nature.
8. Polyembryony: Classification, development, experimental induction, causes and practical value of polyembryony.
9. Apomixis: Types, diplospory, apospory, parthenogenetic development of embryo; causes; genetics and significance of apomixis.
10. Palynology: Pollen morphology, pollen wall features, germination of pollen grains, scope of Palynology.

**Unit-3: Tissue culture**

11. Embryo culture; Introduction, types, objectives, protocol and applications, Somatic embryogenesis: introduction, development of somatic embryos, factors and significance of somatic embryogenesis; Artificial seeds- their advantages and limitations.

12. Anther and Pollen culture: Introduction, history, protocol for anther and pollen culture, advantage of pollen culture over anther culture, factors and significance of anther and pollen culture, use of haploids in crop improvement.
13. Plant Protoplast culture: Introduction , isolation and culture of protoplasts, regeneration of plants and importance, somatic hybridization; introduction , techniques of somatic hybridization, selection of fused protoplast and significance; Cybrids-techniques, advantages and uses.
14. Somaclonal variations; introduction, causes, method of selection and uses of somaclonal variation; somaclonal works in India.

#### **Unit-4: Genetic Engineering**

15. Tools of genetic engineering; Restriction endonuclease; Gel electrophoresis; ligases and probes, cloning vectors; plasmids, cosmids, phage vectors, BAC and YAC vectors.
16. Nucleic acid hybridization: Southern, Northern and western blotting techniques.
17. Polymerase Chain Reaction (PCR); Principles and uses of PCR.
18. Gene transformation of plants; Vector mediated transformation; Agrobacterium- the natural genetic engineer; methods of direct gene transfer in plants, transgenic plants; principles and techniques; exploitation in the production of transgenic plants; transgenic plants for resistance to herbicides, insecticides, viral and other diseases; transgenic plants for molecular farming.

#### **Suggested readings:**

1. Bhojwani S. S. and Bhatnagar S. P. (1999). The embryology of angiosperms. Vikas Pub. House.
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms, Kluwer Academic Publishers.
3. Fahn A (1989) plant anatomy (Third edn) Pergamon Press.
4. Jermy Burgess (1985) An Introduction to Plant Cell Development. Cambridge University Press.
5. Johri B. M. and Srivastava P. S. (2001). Reproductive biology of plants. Narosa Pub. House, New Delhi.
6. Krishnamurthy K.V. (1988) Methods in Plant Histochemistry
7. Lewis Wolpert ( 2002), Principles of Development ( 2nd edition ). Oxford University Press.
8. Raghavan V. (2000) Developmental Biology of Flowering Plants. Springer Verlag.
9. Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH.
10. Collins GB and Shepherd RJ Engineering plants for commercial products and applications. Eds., NY Acad. Of Science Publishers.

**Semester- III**  
**Paper-XII**  
**BOT-C12 (Core Practical-12)**

**Full Marks-100 (End-70+ Int-30)**

1. Anatomical study of the stem showing anomalous secondary growth.
2. Study and identification of tissue elements from the macerated stem.
3. Stigma squashing/Pollen germination.
4. Study of different stages of developing embryo.
5. To compare the rate of imbibitions of starchy and oily seeds (Gram seeds, Mustard seeds, Wheat & Ground nut).
6. To compare the rate of cuticular and non cuticular transpiration (*Opuntia* stem)
7. Study of stomatal index.
8. Techniques of inoculation of the explants to the nutrient medium.
9. Separation of chlorophyll pigments by paper chromatography methods.
10. Biochemical test of Carbohydrates/Proteins/ Lipids.

**Distribution of marks:**

Experiments	:	30 marks
Spotting                      05 x 2	:	10 marks
Records/Models/Charts/Herbarium/Tour Report	:	15marks
Viva Voce	:	15 marks

**Semester- IV**  
**Paper-XIII**  
**BOT-E13 (Elective-A: Theory-I-Microbiology and Plant Pathology)**

**Full Marks-100 (End-70+ Int-30)**

**Microbiology**

**Unit-1: Historical aspects of microbiology:** - Growth of microbiology in 20<sup>th</sup> century and its modern approach.

**Unit-2:** Koch's Postules and its importance in identification of plant disease.

**Unit-3: Sterilization:** - Types, methods and precautions. Culture medium: - Types, composition, methods of preparation and merits & demerits.

**Unit-4: Isolation culture and purification** of viral, bacterial and fungal pathogen: - Types, methods & precautions and preparation of their pure culture.

**Unit-5: General Character and classifications** of Fungi, bacteria, viruses and mycoplasma.

**Unit-6: Viruses-** morphology, ultrastructure, capsid & their arrangement, types of envelops & their composition, viral genome replication.

**Unit-7:** Elementary idea about virioids & prions.

**Unit-8: Mycoplasma:** - Structure and life cycle and diseases caused by mycoplasma.

**Unit-9: Bacteria:** - Bacterial Cell Wall, Genome, genetic recombination, bacterial toxin and interferon.

**Unit-10: Fungal toxins:** - Types, chemical composition and effects.

**Unit-11: Antibiotics:** - Types, mode of action and uses.

**Unit-12:** Microbial food infestation and food poisoning.



**Unit-13: Role of microbes** in Agriculture (with special reference to N<sub>2</sub> – fixation and mycorrhiza), milk industry & beverages industry.

**Unit-14:** Basic concept of Immunology.

**Suggested readings:**

1. Powel, C and D. J. Bagyaraj - V.A. Mycorrhizae.
2. Berry, R. - Industrial mycology (Vol. I).
3. Jeffrey C. Pommerville - Alcamo's Fundamentals of Microbiology.
4. Arora D.R. and B. Arora - Text book of Microbiology.
5. Dubey, R.C. & Maheswari, D.K. A Text Book of Microbiology, 2005, S.Chand & Company.
6. Biswas, S.B. & Biswas, A. An Introduction to Viruses (4th ed.), 1996, Vikas Publishing House.
7. Chakraborty, P., A Text book of Microbiology, New central book agency(P) Ltd.India.
8. Power, C.B. & Dagainawala, H.F. General Microbiology, Vol. I&II, Himalaya Publishing House.
9. Sale, A.J. Fundamental Principles of Microbiology, Latest Ed., Tata McGraw Hill.

**Semester- IV**

**Paper-XIII**

**BOT-E13 (Elective-B: Theory- I- Cytogenetics and Plant Breeding)**

**Full Marks-100 (End-70+ Int-30)**

**Cytogenetics**

**Unit-1: Cell cycle:** Interphase, Mitosis, Cytokinesis, Stages of Meiosis, Synaptonemal complex & its significance in meiosis.

**Unit-2: DNA:** Structure, Function, Replication, DNA damage and repair and recombination.

**Unit-3: RNA:** Types, Structure, Function, Transcription, RNA processing & RNA splicing.

**Unit-4: Physical basis of heredity:** Structure of Chromatin fiber, models and chromosome: structure, organization & function & special types of chromosomes. (Lampbrush, Salivary gland and B chromosome).

**Unit-5: Mendel's Laws of inheritance:** Cytological proof and deviations.

**Unit-6: Interaction of genes;** Quantitative and qualitative inheritance; Cytoplasmic inheritance & sex linked inheritance in plants.

**Unit-7: Sex determination in plants.**

**Unit-8: Fine structure of gene** (Lozene in Drosophila r II in T4 Phage, cistron, recon & mutron).

**Unit-9: Regulation of gene expression:** Operon concept in Prokaryotes.

**Unit-10:** Structural changes in chromosomes; Numerical changes in chromosomes.

**Unit-11:** Gene mutation and mutagens.

**Suggested readings:**

1. Cooper, G.M. The Cell, A molecular approach (2nd ed.), 2000, ASM Press.
2. Weaver, R.F. Molecular Biology (2nd ed./3rd ed.), 2002/2005, McGraw Hill.

3. Malacinski, G.M. Freifelder, Essentials of Molecular Biology (4th ed.), 2003, Narosa Publishing House.
4. Sambamurty, A.V.S.S. Genetics (2nd ed.), 2005, Narosa publishing House.
5. Sharma, A. & Sen, S. Chromosome Botany, 2002, Oxford & IBH Publishing.
6. Sen, S. & Kar, D.K. Cytology & Genetics, 2005, Narosa Publishing House.
7. Miglani, G.S. Advanced Genetics, 2002, Narosa Publishing House.
8. Gupta, P.K. Genetics, 2007, Rastogi Publications.
9. Jain, H.K. Genetics, 1999, Oxford & IBH Publishing Company.

**Semester- IV**  
**Paper-XIII**  
**BOT-E13 (Elective-C: Theory- I-Plant Physiology and Biochemistry)**

**Full Marks-100 (End-70+ Int-30)**

**Plant Physiology**

**Unit-1: Plant water relation:** Diffusion and osmosis, Imbibition, plasmolysis, water potential and chemical potential.

**Unit-2: Absorption of water;** anatomical structure of root, path of movement, mechanism of active and passive absorption, factors affecting water absorption.

**Unit-3: Ascent of sap;** anatomy of pathway, theories to explain mechanism.

**Unit-4: Transpiration;** types, stomatal structure, mechanism of stomatal movement, factors affecting transpiration, antitranspirant and guttation.

**Unit-5: Absorption of mineral salts;** Mechanism of active and passive absorption, factors affecting mineral salt absorption.

**Unit-6: Translocation of solutes;** substances translocated in phloem, direction and speed of translocation, mechanism of phloem transport, transport of ions, loading and unloading mechanism, and factors affecting translocation.

**Unit-7: Mineral nutrition of plants;** deficiency, symptoms and diseases, macro and micro nutrients, chelating agents.

**Unit-8: Response of plants to stress;** physical, chemical, biological ways to adapt to stress.

**Unit-9: Ecological physiology;** principles of plant response to environment, radiation energy, ecosphere, ecotype, phyto-association, allelochemic and allelopathy.

**Unit-10: Growth and development:** general aspect of growth, development and differentiation.

**Unit-11: Growth regulators;** history, structure, biosynthesis, mechanism of action and significance of Auxins, Gibberellins, Cytokinins, abscissic acid and ethylene.

**Unit-12: Physiology of photoperiodism and vernalization.**

**Unit-13: Seed dormancy;** definition, types, mechanism and methods breaking seed dormancy.

**Unit-14: Seed germination.**

**Unit-15: Senescence.**

**Suggested readings:**

1. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
2. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
3. Srivastava, L.M. Plant Growth and Development, 2001, Academy Press.
4. Raman, H. Transport Phenomenon in Plants, 1997. Narosa Publishing House.
5. Verma, V., Plant Physiology, Athena Academi.

**Semester- IV**  
**Paper-XIII**  
**BOT-E13 (Elective-D: Theory- I- Environmental Biology)**

**Full Marks-100 (End-70+ Int-30)**

**General Ecology**

**Unit-1: Natural resources: Definition, Classification:**

- a) Land: Use and abuse, management of Land.
- b) Water: Types of water resources, problems and managements of water.
- c) Forest: Importance and depletion of Forest & management.
- d) Wildlife: Importance and depletion of wildlife & wildlife management.

**Unit-2: Ecosystem:**

- a) Modern concept, structural components, trophic structure, food chain, food web and ecological pyramids.
- b) Structure and function of some Forest, Grassland and Pond ecosystem.
- c) Ecological energetic: Concept and mode of energy flow in ecosystem.
- d) Productivity: Types and methods of Primary productivity and its measurement.

**Unit-3: Community:**

- a) Structure: Analytic and synthetic characters with emphasis on IVI and species diversity Index(H).
- b) Ecological niche, edges and ecotones.
- c) Succession: Types and process of succession, hydrosere and xerosere, concept of climax.

**Unit-4: Plant Geography:**

- a) Biomes of the world.
- b) Major vegetation types of India.
- c) Major floristic regions of India.

**Unit-5: Plant Biodiversity:**

- (a) Plant diversity: Concept, status in India, Utilization and concerns.
- (b) Strategies for plant conservation; in Situ conservation: Protected areas, sanctuaries, National Parks, biosphere reserves, wetland, mangroves, sacred groves and coral reefs for conservation of wild biodiversity.
- (c) Ex Situ conservation: Botanical gardens, gene banks, seed banks and cryobanks.
- (d) Genetically modified (GM) crops.

**Suggested readings:**

1. Schulze, E.D., Beck, E. And K. Muller-Hohenstein. 2005. Plant Ecology. Springer. New York.
2. Odum E.P. Gray, W. Barrelet 2004. Fundamentals of Ecology. 15th edition. Thomas Asia Pvt. Ltd.
3. Chawla, S. 2011. A text book of Environment & Ecology. Tata Mc Graw-Hill, New Delhi.
4. Chapman, J.L. and Reiss, M.J. 1999. Ecology; Principles and Applications. II Ed. Cambridge University Press. New York.
5. Smith, R.L. 1996. Ecology and Field Ecology, Harper Collins, New York.
6. Misra, R. 1968. Ecology work book, Oxford & IBH, New Delhi.

**Paper-XIV**  
**BOT-E14 (Elective-A: Theory- II-Microbiology and Plant Pathology)**

**Full Marks-100 (End-70+ Int-30)**

**Plant Pathology**

**Unit-1: History and growth of plant pathology** in 20<sup>th</sup> century and its modern approach.

**Unit-2: Contribution of various scientists** in the field of plant pathology.

**Unit-3: Important terms** and classification of plant diseases and symptoms.

**Unit-4: Mechanism of pathogenesis:** contact, penetration, entry and development of diseases.

**Unit-5: Toxin:** Toxins and their role in pathogenesis.

**Unit-6: Cell wall degrading enzymes** and their role in pathogenesis.

**Unit-7: Physiology of parasitism:** Effects of infection on the physiology of the host with special reference to permeability, photosynthesis, respiration.

**Unit-8: Defence mechanism:** Structural and biochemical defence.

**Unit-09: Control o plant diseases:** Cultural, chemical and biological management.

**Unit-10: Methods of plant disease forecasting.**

**Unit-11: Study of symptoms, etiology, disease cycle and control measure of following diseases:**

- a. Fungal diseases: - Green ear of bajra, False smut of rice, Gall of coriander, Rust of linseed & Tikka disease of Groundnut.
- b. Bacterial diseases: - Blight of rice, Citrus canker, Black leg and soft rot of Potato.
- c. Viral diseases: - Leaf curl of Tomato, leaf curl of Papaya, yellow vein mosaic of Bhindi.
- d. Mycoplasmal diseases: - Little leaf of Brinjal & Grassy shoot of Sugarcane.
- e. Nematodal diseases: - Root knot of vegetable & Ear cockle of wheat.

**Suggested readings:**

1. Mehrotra, R.S. & Agarwal, A. plant Pathology (2nd ed.), 2003, Tata McGraw Hill.
2. Singh, R.S. Principles of Plant Pathology (4th ed.), 2002, oxford & IBH Publishing Com.
3. Rangaswami, G.K. & Mahadevan, A. Diseases of Crop Plants in India, Prentice Hall.
4. Sharma, P.D. Plant Pathology (2nd ed.), Rastogi Publications.
5. Mandal, A.K., Text book of Pathology, A.P. Publications.

**Full Marks-100 (End-70+ Int-30)**

**Plant Breeding**

**Unit-1: Principles of Plant breeding:** Introduction, selection, hybridization, polyploidy and mutation.

**Unit-2: Methods of breeding:** in self pollinated, cross pollinated and asexually propagated plants.

**Unit-3: Improvement:** and origin of wheat, rice, maize and cotton in India.

**Unit-4: Breeding:** for disease resistance.

**Unit-5: Mutation:** in crop improvement.

**Unit-6: Polyploidy:** in crop improvement.

**Unit-7: Hybrid vigour:** and its role in plant improvement.

**Unit-8: Inbreeding depression:** and its role in plant breeding.

**Unit-9: Recombination:** DNA Technology & PCR.

**Unit-10: Gene transfer:** method and synthesis of transgenic plants.

**Unit-11:** Genetically manipulated crops.

**Unit-12: Method of gene transfer in plants:** Vector – mediated gene transfer, Agrobacterium tumifascience: the natural genetic engineer.

**Unit-13: Biostatistics:** Mean, median, mode, standard, error, standard deviation & Chi-square test.

**Suggested readings:**

1. Allard R.W 1995. Principles of Plant Breeding. John Wiley and Sons, Inc., Singapore.
2. Sharma J.R 1994 Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.
3. Singh B.D 1996 Plant Breeding – Principles and methods. Kalyani Publications, Ludhiana.
4. Chahal G.S and Gosal S.S 2002. Principles and procedures of Plant Breeding, Narosa Publishing House, New Delhi.
5. Verma and Agarwal, Genetics, S. Chand Co, New Delhi.
6. Toun N and Trempey Janire 2004 (First Indian Reprint). Fundamental Bacterial Genetics. Blackwell Publishing Co.
7. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana.
8. Gupta P.K Genetics and Cytogenetics, Rastogi Publications.
9. Maloy S.R, Cronan J.R and Freifelder D 2006. Narosa Publishing House, New Delhi.

**Semester- IV  
Paper-XIV**

**BOT-E14 (Elective-C: Theory- II-Plant Physiology and Biochemistry)**

**Full Marks-100 (End-70+ Int-30)**

**Biochemistry**

**Unit-1: Structure of atoms,** molecules and chemical bonds.

**Unit-2: Law of thermodynamics.**

**Unit-3: Bioenergetics.**

**Unit-4: Structure and function** of primary metabolites; carbohydrates, proteins and fats.

**Unit-5: Structure and functions** of secondary metabolites; terpenoids, phenols and alkaloids.

**Unit-6: Photosynthesis;** Pigment system, Photophosphorylation, Calvin cycle, Hatch and Slake pathway, CAM pathway, photorespiration and factors affecting photosynthesis.

**Unit-7: Respiration:** Glycolysis, fermentation, Kreb's cycle, Electron transport system, Hexose mono phosphate shunt, Theories of phosphorylation, factors affecting rate of respiration.

**Unit-8: Enzymes;** nature, properties and classification, enzyme energetic, mode and mechanism of action, factors affecting enzymes activities.

**Unit-9: Nitrogen metabolism;** amino acid metabolism nitrogen fixation in free and symbiotic organisms.

**Unit-10: Fat metabolism;** nature and classification, biosynthesis degradation of fats, B- oxidation and alpha oxidation, glyoxylate cycle.

**Unit-11: Nucleic acid metabolism.**

**Suggested readings:**

1. Plant Physiology, biochemistry and molecular biology. David, T: Dennis and Davis Turnip. Longman. Scientific and technical U.K. 1990.
2. Plant Biochemistry Voet, D and Voet J.G. International.
3. Outlines of biochemistry. 5th edition Con E.E. and Stump P.K. Willey.
4. Principles of biochemistry, Lehninger, A.L. 1982 CBS Publication.
5. Biochemistry, Strayer W.H. 1976. Foreman Company.
6. Plant Biochemistry. P.M. Dey and J.B. Harborne .
7. Plant Biochemistry. Hans-Walter Heldt.

**Semester- IV  
Paper-XIV**

**BOT-E14 (Elective-D: Theory-II- Environmental Biology)**

**Full Marks-100 (End-70+ Int-30)**

## **Environmental Issues**

### **Unit-1: Limnology:**

- a) Lentic and Lotic ecosystem, quality of drinking water, strategies for conservation of fresh water.
- b) Physico-chemical characteristic of lentic and lotic system – Temperature, PH, conductivity, dissolved Oxygen and free CO<sub>2</sub>, B.O.D. and C.O.D., Total Nitrogen, Phosphorus, TDS (Total Dissolved Solid).
- c) Biological diversity of aquatic ecosystem with special reference to algae and mesophytes.
- d) Measurement of Primary productivity in fresh water ecosystem.
- e) Depletion of water resources: Alarming situation of ground and surface resources, rain water harvesting and recharging aquifers.

### **Unit-2: Pollution Ecology:**

- a) Solid waste management: Source, generation and classification of solid waste.
- b) Management and utilization of solid waste.
- c) Fly ash and mine spoil and their management.
- d) Air pollution: Causes, source and critical air pollution and their Indian standard.
- e) Primary and secondary air pollutant and pollution due to coal and stone mines.
- f) Radiation pollution: Types, measurement, sources, impact on health and its mode of action, strategy for control/minimizing radiations.
- g) Climatic changes – Climatic change vis-à-vis global warming, present status, future projections of climatic change, impact, adaptation and mitigation of climatic change.
- h) Biotechnology for pollution abatement: Bioscrubbe, Biofilter, Biochips & Biosensor.
- i) Concept of bioremediation, hyper accumulators, bioremediation of polluted water, air and soil.
- j) Waste water management/treatment: Technology of waste water treatment and chemical and biological treatment.
- k) Anthropogenic activities and its impact on environment.
- l) Water and Forest Protection Act.
- m) Bio indicators, Convention on Biological Diversity (CBD), Kyoto protocol and carbon trading, IUCN, Gene campaign, Rare, threatened and endangered flora of India.

### **Suggested readings:**

1. MN Rao, McGrace Hill 1993 – Air pollution.
2. C.S.Rao- Environmental Engineering and technology.
3. S.P. Misra and Pandey- Essential Environmental Studies.
4. Y.Anjaneyulu- Introduction to Environmental Science.
5. P.D.Sharma- Ecology and Environment.
6. P.C.Santra- Environmental Science.

## **Semester- IV**

### **Paper-XV**

## **BOT-E15 (Elective-A: Practical-Microbiology and Plant Pathology)**

**Full Marks-100 (End-70+ Int-30)**



1. Staining and identification of bacteria.
2. Sterilization of Glassware, tools & media and host/pathogen.
3. Preparation of PDAM or CDAM.
4. Isolation, identification, incubation of fungal/bacterial pathogens to healthy hosts.
5. Description, principle, theory, structure and functioning of Autoclave.
6. Spore measurement by stage and ocular micrometer.
7. Preparation of common fungicide and their evaluation of efficacy.
8. Histopathological study of common diseases of local area.

Distribution of marks-

- |                                       |   |           |
|---------------------------------------|---|-----------|
| 1. Experiments                        | = | 30 marks. |
| 2. Spotting            05 x 2         | = | 10 marks. |
| 3. Records/Models/Charts/ Tour Report | = | 15marks.  |
| 4. Viva Voce                          | = | 15 marks. |

*It is mandatory to visit minimum one institute or place of botanical interest (Two local tours and one long tour is mandatory)*

**Semester- IV**  
**Paper-XV**  
**BOT-E15 (Elective-B: Practical-Cytogenetics and Plant Breeding)**

**Full Marks-100 (End-70+ Int-30)**

1. Methods of preparation of Prefixatives.
2. Methods of preparation of Acetocarmine & Fuelgen stain.
1. Squashing techniques.
2. Technique and method of permanent preparation of cytological materials.
3. Karyotype study of Metaphase and Anaphase chromosomes from root tops (*Allium, cepa, Vicia faba, Zea, mays* etc.)
4. Study of chromosomes of different stages of mitosis by squash technique.
5. Study of different stages of meiosis from the floral buds (*Allim, Vicia, Zea, Rhoeo* etc.)
6. Study of abnormalities in mitosis and meiosis.
7. Problem related to Mendalian ratio and their modifications; statistical analysis and genetic explanation.
8. Emasculation, hybridization techniques.
9. Study of chromocentres found in the stigmatic receptive cell of crucifers.
10. Estimation of DNA by Spectrophotometer.
11. Study of Chaisma frequency in *Allium, Vicia, Rhoeo* or *Coccinia*.
12. Study of effects of Colchicines and gammexine on somatic chromosomes.
13. Preparation of Idiograms/Karyograms of *Allium, Vicia, Zea, Rhoeo* and *Pisum*.

**Distribution of marks-**

- |                                      |   |           |
|--------------------------------------|---|-----------|
| 1. Experiments                       | = | 30 marks. |
| 2. Spotting      05 x 2              | = | 10 marks  |
| 3. Records/Models/Charts/Tour Report | = | 15marks   |
| 4. Viva Voce                         | = | 15 marks. |

*It is mandatory to visit minimum one institute or place of botanical interest (Two local tours and one long tour is mandatory)*

**Semester- IV**  
**Paper-XV**  
**BOT-E15 (Elective-C: Practical-Plant Physiology and Biochemistry)**

**Full Marks-100 (End-70+ Int-30)**

1. Determine DPD of potato tuber.
2. Compare the rate of Imbibitions of starchy and fatty seeds.
3. Study and determination of stomatal index.

4. Study the relative rate of transpiration from leaf surface s of different plants.
5. Compare the relative rate of transpiration from the lower and upper surface of the leaf by leaf cup method.
6. Demonstrate the relation between absorption of water and transpiration.
7. Demonstrate the rate of transpiration by using Potometer.
8. Demonstrate the effect of different wave length of light on photosynthesis.
9. Demonstrate the effect of different concentration of CO<sub>2</sub> on photosynthesis.
10. Separation of chloroplast pigments by chromatography paper or solvent method.
11. Determine the RQ value of different respiratory substrate by Respirometer method.
12. Detect and estimate the glucose , protein and fat from different plant materials
13. Separate amino acids, proteins, nucleic acids and secondary metabolites from different plant material by paper chromatography or by the help of any latest technique.

Distribution of marks-

1. Experiments	=	30 marks.
2. Spotting            05 x 2	=	10 marks
3. Records/Models/Charts/ Tour Report	=	15marks
4. Viva Voce	=	15 marks

*It is mandatory to visit minimum one institute or place of botanical interest (Two local tours and one long tour is mandatory)*

**Semester- IV**  
**Paper-XV**  
**BOT-E15 (Elective-D: Practical-Environmental Biology)**

**Full Marks-100 (End-70+ Int-30)**

1. To determine the pH/Dissolve Oxygen/Free CO<sub>2</sub>.
2. To determine the chloride content of water.
3. Collection, identification of different biota of fresh water ecosystem.
4. To determine the minimum size of quadrat by species area Curve method.

5. To determine the frequency/density/abundance, IVI and species diversity index (H) of grassland vegetation.
6. To determine BOD/COD of different types of water sample.
7. Isolation of algae/bacteria/fungi from aquatic ecosystem.
8. To determine the productivity by dark and light Bottle method.
9. Problem based Standard error/Standard deviation/Chi-square test.
10. Ecological anatomical study of some xerophytes and hydrophytes.

Distribution of marks-

- |                                      |   |           |
|--------------------------------------|---|-----------|
| 1. Experiments                       | = | 30 marks. |
| 2. Spotting      05 x 2              | = | 10 marks. |
| 3. Records/Models/Charts/Tour Report | = | 15marks.  |
| 4. Viva Voce                         | = | 15 marks. |

*It is mandatory to visit minimum one institute or place of botanical interest (Two local tours and one long tour is mandatory)*

**Semester- IV**  
**Paper-XVI**

**BOT-E16 (Elective-A: Dissertation/Project Work-Microbiology and Plant Pathology)**

**Full Marks-100**

Students shall be required to carry out a project work and submit a concise dissertation on his/her project work. The concerned Head of the Department shall provide the topic to the students and also appoint teacher for supervising the project work. Students have to submit dissertation in the Department at the end of the session, before theory paper examination begins.

Distribution of marks: -

Facts/contents and analysis that is presentation (PPT)	-	50 marks
Concise Dissertation/Project in written	-	25 marks
Viva-Voce	-	25 marks

**Semester- IV**  
**Paper-XVI**

**BOT-E16 (Elective-B: Dissertation/Project Work-Cytogenetics and Plant Breeding)**

**Full Marks-100**

Students shall be required to carry out a project work and submit a concise dissertation on his/her project work. The concerned Head of the Department shall provide the topic to the students and also appoint teacher for supervising the project work. Students have to submit dissertation in the Department at the end of the session, before theory paper examination begins.

Distribution of marks: -

Facts/contents and analysis that is presentation (PPT)	-	50 marks
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Concise Dissertation/Project in written	-	25 marks
Viva-Voce	-	25 marks

**Semester- IV  
Paper-XVI**

**BOT-E16 (Elective-C: Dissertation/Project Work-Cytogenetics and Plant Breeding)**

**Full Marks-100**

Students shall be required to carry out a project work and submit a concise dissertation on his/her project work. The concerned Head of the Department shall provide the topic to the students and also appoint teacher for supervising the project work. Students have to submit dissertation in the Department at the end of the session, before theory paper examination begins.

Distribution of marks: -

Facts/contents and analysis that is presentation (PPT)	-	50 marks
Concise Dissertation/Project in written	-	25 marks
Viva-Voce	-	25 marks

**Semester- IV**  
**Paper-XVI**  
**BOT-E16 (Elective-D: Dissertation/Project Work-Environmental Biology)**

**Full Marks-100**

Students shall be required to carry out a project work and submit a concise dissertation on his/her project work. The concerned Head of the Department shall provide the topic to the students and also appoint teacher for supervising the project work. Students have to submit dissertation in the Department at the end of the session, before theory paper examination begins.

Facts/contents and analysis that is presentation (PPT)	-	50 marks
Concise Dissertation/Project in written	-	25 marks
Viva-Voce	-	25 marks

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