

# **BOTANY - SYLLABUS**

## **Subject:- Botany** **Semester- I**

### **Course Overview:-**

This paper consists of mainly Fundamental Botany, Industrial Botany I, Industrial Botany II and Environmental Botany.

### **Learning Objectives:-**

- 1) To discuss Origin of life, Basic Taxonomical Classification, Plant Life Cycle pattern and Evolution, Darwin's Theory of Evolution, Species Concept, Mechanism of Speciation.
- 2) To focus on Environmental Botany *i.e.*, Different types of Pollution and their effect on Human being.
- 3) To explain Industrial Botany which include Agro-Industries, Microbial Fermentation, Plant Nursery and Floriculture.
- 4) To discuss *Spirulina* Culture Technique, Mushroom Production and Harvesting.
- 5) To focus on Commercial Production of Ethyl Alcohol and Citric acid and Penicillin.

### **Learning Outcome:-**

- 1) Students will learn about Basic Taxonomical Classification and their Significance.
- 2) Students will upgrade their knowledge on different Environmental Pollution and their impact on Plants and Human beings.
- 3) Students will develop knowledge on Floriculture and different kinds of Propagation Techniques
- 4) Student will learn about different Microbial Culture, Agri-Industrial Botany and different types of Plant Nursery, Floriculture, Different types of Grafting.

### **Suggested Readings:-**

- 1) Biotechnology- U. Satyanarayan and U. Chakrapani
- 2) Textbook of Botany-S.N. Pandey and P.S. Trivedi
- 3) Textbook of Botany-Hait, Bhattecharya, Ghosh
- 4) Studies in Botany- J. Guha and S. Chowdhury

**Subject:- Botany**  
**Semester- II**

**Course Overview:-**

This paper mainly covers Algae, Bryophyte, Pteridophyte, Gymnosperm and Palaeobotany.

**Learning Objectives :-**

- 1) To focus on study of Thallus Organisation, Life History, Ultra Structure of Plastid and Flagella, Origin and Evolution of Sex and Economic Importance of Algae.
- 2) To explain the General Account, Life History, Origin, Evolution, Reproduction, Gametophytic and Sporophytic Structures of Bryophytes and Pteridophytes.
- 3) To discuss Life History, Distribution, Vegetative and Reproductive Structure of Gymnosperms.
- 4) To explain different types of Plant Fossils (including Fossil Pteridophytes and Fossil Gymnosperms), Fossilization Process, and their Economic Importance.

**Learning Outcomes (Theory) :-**

- 1) Students will learn about Thallus Organization, Life History, Economic Importance of selected species of Algae, Diatom and Bryophytes.
- 2) Students will learn about Life History, Sporophytic and Gametophytic Structure of Pteridophytes and Gymnosperms.
- 3) Students will learn about types of Fossils and different Modes of Preservation.

**Learning Outcomes (Practical) :-**

- 4) Students will learn to work out on different species of Algae and Pteridophyte.
- 5) Students will learn how to identify different species of Algae, Bryophytes, Pteridophytes, Gymnosperms and Fossil Plants.

**Suggested Readings:-**

- 1) Studies in Botany (Vol 1)-Mitra, Guha, Chowdhury
- 2) A Text Book of Botany (Vol 1)- Hait, Bhattecharya, Ghosh
- 3) College Botany- Ganguli, Kar, Santra

**Subject:- Botany**  
**Semester- III**

**Course Overview:-**

This paper mainly covers Fungi and Plant Resource Utilization (Economic Botany), Microbiology and Plant Pathology.

**Learning Objectives:-**

- 1) To discuss about fungal classification upto Class Characters.
- 2) To focus on Lichen and their significance.
- 3) To explain life history of *Agaricus*, *Ascobolus*, *Mucor*, *Synchytrium*, *Penicillium*, *Polyporus* and *Fusarium*.
- 4) To discuss bacterial cell structure and genetic recombination replication of Bacteriophage; Disease cycle of Late Blight of Potato, Brown Spot of Rice and Black Stem Rust of Wheat.
- 5) To focus on Economically Important Plants and their uses.
- 6) To discuss on Cultivation of Rice, Jute, Rubber, Tea.
- 7) To discuss about Plant Quarantine.

**Learning Outcomes (Theory):-**

- 1) Students learn fungal classification upto class characters and life history of *Agaricus*, *Ascobolus*, *Mucor*, *Synchytrium*, *Penicillium*, *Polyporus*, *Mucor* and *Fusarium* sp.
- 2) Students will learn economically important plants and their general uses.
- 3) Students will learn Bacterial cell structure, genetic recombination, replication of Bacteriophage and different plant diseases, Parsexuality, Plant quarantine.

**Learning Outcomes (Practical):-**

- 1) Students will learn work out of *Ascobolus*, *Mucor*, *Synchytrium*, *Penicillium*, *Polyporus*, *Mucor* and *Fusarium* sp.
- 2) Students will learn Microscopic examination of Bacteria by Gram staining procedure.
- 3) Students will learn about preparation of Fungal media, Serilization process, Inoculation of pathogen from diseased leaf.

**Suggested Readings :-**

- 1) Studies in Botany (Vol 1)- Mitra, Guha, Chowdhury
- 2) A Textbook of Botany (Vol 1)- Hait, Bhattecharya, Ghosh.
- 3) Botany for Degree Students- Dr. B.P. Pandey
- 4) College Botany- Ganguli, Kar, Santra.

**Subject:- Botany**  
**Semester- IV**

**Course Overview:-**

This paper mainly consists of Morphology, Embryology, Taxonomy, Anatomy, Ecology and Phytogeography.

**Learning Objectives:-**

- 1) To discuss morphology, embryology and taxonomy of angiospermic plants.
- 2) To explain the general characteristics and distinguishing characters of selected families.
- 3) To make the student understand about Placentation and Fertilization method.
- 4) To discuss the nomenclature and rules of ICBN.
- 5) To discuss the Microsporogenesis, Megasporeogenesis, Embryo and Endosperm Development.
- 6) To make the student learn about Ecological Succession, Hydrosere, Xerosere, Ecological Adaptation, Endemism, Red Data Book and Phytogeography.
- 7) To explain the Anatomical characteristics of plants.
- 8) To make them learn work out on Taxonomy of Angiosperms Anatomy of Angiosperm, and Identification of some selected slides with reason.

**Learning Outcomes (Theory):-**

- 1) Students will learn about Morphology and Taxonomy of some Angiospermic plants.
- 2) Students will learn about Anatomy of Cell wall, Meristematic and Permanent Tissue and Vascular bundle.
- 3) Student will learn about Normal secondary growth.
- 4) Students will learn Ecological succession, Hydrosere, Xerosere, Endemism, Ecological adaptation, Red Data Book and Phytogeography.
- 5) Student will learn about the Nomenclature and Rules of ICBN.
- 6) Student will learn about the Microsporogenesis, Megasporeogenesis, Embryo and Endosperm Development.

**Learning Outcomes (Practical) :-**

- 1) Students will learn work out on morphological and anatomical features of different Angiospermic plants belonging to different Families.
- 2) Students will learn how to identify plants based on different morphological and anatomical features with reasons.
- 3) Students will learn how to collect different plants from different ecological regions and how to prepare Herbariums.

**Suggested Readings :-**

- 1) Taxonomy of Angiosperm- V. Singh and V.K.Jain
- 2) College Botany (Vol 2)- Gangulee and kar.
- 3) College Botany (Vol 1)- Gangulee, Das, Datta.
- 4) Systematic Botany- S.C. Datta.
- 5) Textbook of Botany (Vol 2)- Hait, Bhattacharya, Ghosh.

**Subject:- Botany**  
**Semester- V**

**Course Overview:-**

This paper mainly consists of Cell and Molecular Biology, Cytogenetics, Plant Breeding, Plant Physiology, Plant Biotechnology and Biostatistics.

**Learning Objectives :-**

- 1) To make the students learn about Cell cycle, Cell division structure and function of Cell organelles.
- 2) To discuss chromosome morphology, organisation of eukaryotic chromosome Structure and features of Nucleic acid.
- 3) To explain DNA Replication, Transcription, Translation, Gene Mutation.
- 4) To focus on Mendelian Inheritance, Crossing Over, Complete and Incomplete Linkage.
- 5) To discuss different techniques of Plant Breeding.
- 6) To explain Plant Physiology and different techniques of Plant Tissue Culture.
- 7) To make the student learn work out on Mitotic and Meiotic study, study on Pollen Sterility- Fertility, Detection of Organic acids Carbohydrate from unknown sample.
- 8) To make student learn about different plant physiological experiments.

**Learning Outcome (Theory):-**

- 1) Students will learn about Cell cycle, Cell division, Structure and Function of different Cell Organelles.
- 2) Students will learn chromosome morphology, organisation of eukaryotic chromosome Structure and features of nucleic acid.
- 3) Students will learn different molecular processes like DNA replication, Transcription, Translation, Gene Mutation, Linkage, different Chromosomal aberrations etc.
- 4) Students will learn different Breeding and Hybridization techniques in Plants.
- 5) Students will know about Biostatistics.
- 6) Students will learn about different physiological process which are involved in plants and what are the different techniques used in plant tissue culture process.

**Learning Outcome (Practical) :-**

- 1) Students will know about different stages of normal and abnormal Mitotic and Meiotic stages and how to prepare the permanent slides.
- 2) Students will get a brief idea about Pollen Sterility and Fertility.
- 3) Students will learn about how to do various hands on plant physiological experiments like Photosynthesis, Respiration,  $Q_{10}$ , Chromatography, Imbibitions, Transpiration and Evaporation.
- 4) Students will learn about different instruments and techniques used in Plant Tissue Culture process.
- 5) Students will understand about different techniques of Plant Breeding including Emasculation process.
- 6) Students will learn about different Biochemical studies like detection of Organic acids and Carbohydrate from unknown sample.
- 7) Students will get a brief idea how Statistical data are used to verify different Biological Experiments.

**Suggested readings :-**

- 1) Plant Physiology and Biotechnology- H.S. Srivastava
- 2) Principals of Genetics- Gardner,E. J. Simmons, M. J. Snustad.
- 3) Studies in Botany (Vol 2)- Mitra, Guha, Chowdhury
- 4) Cell Biology- C.B. Power

**Subject:- Botany**  
**Semester- VI**

**Course Overview:-**

This paper mainly consists of Biochemistry, Plant Physiology, Pharmacognosy and Plant Biotechnology.

**Learning Objectives:-**

- 1) To make the students learn about different bonds, classification of Carbohydrates, Proteins, Lipids, Amino acids, Enzymes, Glycolysis, TCA cycle, Membrane chemistry, Signal transduction etc.
- 2) To discuss Water potential, Photosynthesis pathways, Respiration, N- metabolism, Phytohormones etc.
- 3) To explain importance of Pharmacognosy, about Drug and its commercial production.
- 4) To focus on different Secondary Metabolites present in plants, their production and utility etc.
- 5) To explain different techniques of Plant Tissue Culture.
- 6) To make the student learn about detection of Organic acids, Carbohydrate from unknown sample.
- 7) To make student learn about plant physiological experiments on Photosynthesis, Respiration, Transpiration.
- 8) To provide a basic environment for performing a Scientific Project Work.

**Learning Outcome (Theory):-**

- 8) Students will learn different Bonds, Classification of Carbohydrates, Proteins, Lipids, Amino Acids, Enzymes, Glycolysis, TCA Cycle, Membrane Chemistry, Signal Transduction etc.
- 9) Students will learn Water Potential, Photosynthesis Pathways, Respiration, N- Metabolism, Phytohormones etc.
- 10) Students will importance of Pharmacognosy, about Drugs and its commercial production.

**Learning Outcome (Practical) :-**

- 1) Students will learn techniques Titration, Protein Estimation etc.
- 2) Students will learn different techniques of Plant Tissue Culture.
- 3) Students will learn about detection of Organic acids, Carbohydrate, Steroids, Alkaloids from unknown sample.
- 4) Students will learn how to do a scientific research and how to write a Scientific Project.

**Suggested Readings:-**

- 1) Plant physiology and Biotechnology-H.S.Srivastava
- 2) Principles of Genetics- Gardner, E. J. Simmons, M. J. Snustad.
- 3) Studies in Botany (Vol 2)- Mitra, Guha, Chowdhury.
- 4) Cell Biology- C.B Power.
- 5) Textbook of Botany (Vol 3)- Hait, Bhattacharya, Ghosh.

# **TRIPURA UNIVERSITY**

(A Central University)

Suryamaninagar – 799022

Syllabus

OF

Botany

(General & Major)

Semester – I-VI

Year 2014

# Botany (General)

## Semester Examination System

Duration: 3 Years (Six Semesters)

Semester	Theoretical Marks	Practical Marks	Total Marks
Semester - I	100 (IA*-20+ES*-80)	-	100
Semester - II	50 (IA-10+ES-40)	50 (IA-10+ES-40)	100
Semester - III	50 (IA-10+ES-40)	50 (IA-10+ES-40)	100
Semester - IV	50 (IA-10+ES-40)	50 (IA-10+ES-40)	100
Semester - V	50 (IA-10+ES-40)	50 (IA-10+ES-40)	100
Total	300	220	500

\***IA**= Internal Assessment; \***ES**= End Semester Examination

## Credit distribution B.Sc. (General) in Botany

Semester	Paper No.	Credit distribution			Total Credits/Semester
		L	T	P	
I	BT - 101 (T)	3	1	0	4
II	BT - 201 (T)	2	0	0	2
	BT - 202 (P)	0	0	2	2
III	BT - 301 (T)	2	0	0	2
	BT - 302 (P)	0	0	2	2
IV	BT - 401 (T)	2	0	0	2
	BT - 402 (P)	0	0	2	2
V	BT - 501 (T)	2	0	0	2
	BT - 502 (P)	0	0	2	2
Total Credits		11	1	8	20

**L = Lecture, T = Tutorial, P = Practical**

## Botany (General)

### Course Structure

Course Title	Full Marks	Total Credits
<b>Semester I</b> BT 101 (Theory) (Fundamental, Environmental and Industrial Botany)	100	4
<b>Semester II</b> BT 201 (Theory) (Algae, Bryophytes, Pteridophytes, Gymnosperms & Paleobotany)	50	2
BT 202 (Practical) – Based on Theory Course – BT201	50	2
<b>Semester III</b> BT 301 (Theory) (Microbiology, Fungi, Plant Pathology & Plant Resource Utilization)	50	2
Bt 302 (Practical) – Based on Theory Course – BT301	50	2
<b>Semester IV</b> BT 401 (Theory) (Morphology, Taxonomy, Anatomy, Ecology & Phytogeography)	50	2
BT 402 (Practical) Based on Theory Course – BT401	50	2
<b>Semester V</b> BT 501 (Theory) (Cell & Molecular Biology, Cytogenetics & Plant Breeding, Plant Physiology & Plant Bio-technology)	50	2
BT – 502 (Practical) Based on Theory Course – BT501	50	2

**Syllabus for B.Sc. Botany (General)**  
**Semester – I**  
**(Theoretical)**

**Paper – BT 101**

**Full Marks – 100**  
**Total Lectures – 48 Periods**  
**(Each Period = 1 hour)**

**Unit – I: (Fundamental Botany)**

**12 Periods**

- 1.1. Origin of life, Difference between plant and animal cell.
- 1.2. Three domains of classification – Archaea, Bacteria, Eukaryota.
- 1.3. History of Plant classification: Natural (Bentham & Hooker), Artificial (Linnaeus) and phylogenetic (Hutchinson) system of Classification.
- 1.4. Plant life cycle pattern & alternation of generation.
- 1.5. Darwin's theory of evolution, Species concept, Isolation & mechanism of speciation.

**Unit – II: (Environmental Botany)**

**12 Periods**

- 2.1. Pollution : Definition and categories
- 2.2 Air pollution : Types and sources of air pollutants and their effects on plants and animals.
- 2.3 Water pollution : Types and sources of pollutants and their effects on plants and animals.
- 2.4 Soil pollution : Sources of pollutants and their effects on living organisms.
- 2.5 Noise pollution, heavy metal pollution and radioactive pollution.

**Unit – III: Industrial Botany – I (Agri Industries and Microbial fermentation and food)**

**12 Periods**

- 3.1 Organic farming – Concept, need, types of organic fertilizers, advantages and limitations.
- 3.2 Importance of seed industries, Seed production. Seed processing and marketing, major seed industries & corporation of India.
- 3.3 Production of SCP from algae – Spirulina culture technique.
- 3.4 Mushroom production and harvesting (*Volvariella* sp.)
- 3.5 Commercial production of Ethyl alcohol and Citric acid

**Unit – IV: Industrial Botany – II (Plant Nursery and Floriculture Industry) 12 Periods**

- 4.1 Concept and types of nurseries: ornamental plant nursery, fruit plant nursery and vegetable plant nursery (with reference to infrastructure required and commercial applications).
- 4.2 Propagation methods: Seed propagation, natural vegetative propagation and artificial vegetative propagation (Cutting, Layering and Grafting)
- 4.3 Introduction to floriculture: Important floricultural crops, open cultivation practices, harvesting and marketing.

**B.Sc. Botany (Major)**  
**Semester Examination System**  
**Duration: 3 Years (Six Semesters)**

<b>Semester</b>	<b>Theoretical Marks</b>	<b>Practical Marks</b>	<b>Total Marks</b>
Semester - I	100 (IA-20+ES-80)	-	100
Semester - II	60 (IA-12+ES-48)	40 (IA-8+ES-32)	100
Semester - III	60 (IA-12+ES-48)	40 (IA-8+ES-32)	100
Semester - IV	60 (IA-12+ES-48)	40 (IA-8+ES-32)	100
Semester - V	60 (IA-12+ES-48)	40 (IA-8+ES-32)	200
Semester - VI	60 (IA-12+ES-48)	40 (IA-8+ES-32)	200
<b>Total</b>	<b>480</b>	<b>320</b>	<b>800</b>

**Credit distribution**  
**B.Sc. (Major) in Botany**

<b>Semester</b>	<b>Paper No.</b>	<b>Credit distribution</b>			<b>Total Credits/Semester</b>
		<b>L</b>	<b>T</b>	<b>P</b>	
I	BT – 101 (T)	3	1	0	4
II	BT – 201 (T)	2	0	0	2
	BT – 202 (P)	0	0	2	2
III	BT – 301 (T)	2	0	0	2
	BT – 302 (P)	0	0	2	2
IV	BT – 401 (T)	2	0	0	2
	BT – 402 (P)	0	0	2	2
V	BT – 501 (T)	4	0	0	4
	BT – 502 (P)	0	0	4	4
VI	BT – 501 (T)	4	0	0	4
	BT – 502 (P)	0	0	4	4
<b>Total Credits</b>		<b>17</b>	<b>1</b>	<b>14</b>	<b>32</b>

**L = Lecture, T = Tutorial, P = Practical**

**Botany (Major)**  
**Course Structure**

Course Title	Full Marks	Total Credits
<b>Semester I</b> BT 101 (Theory) (Fundamental, Environmental and Industrial Botany)	100	4
<b>Semester II</b> BT 201 (Theory) (Algae, Bryophytes, Pteridophytes, Gymnosperms & Paleobotany)	50	2
BT 202 (Practical) – Based on Theory Course – BT201	50	2
<b>Semester III</b> BT 301 (Theory) (Microbiology, Fungi, Plant pathology & Plant Resource Utilization)	50	2
Bt 302 (Practical) – Based on Theory Course – BT301	50	2
<b>Semester IV</b> BT 401 (Theory) (Morphology & Embryology, Taxonomy, Anatomy, Ecology & Phytogeography)	50	2
BT 402 (Practical) Based on Theory Course – BT401	50	2
<b>Semester V</b> BT 501 (Theory) (Cell & Molecular Biology, Cytogenetics, Plant breeding and Biostatistics)	100	4
BT – 502 (Practical) Based on Theory Course – BT501	100	4
<b>Semester VI</b> BT 601 (Theory) (Biochemistry, Plant Physiology, Pharmacognosy and Plant Biotechnology)	100	4
BT – 602 (Practical) Based on Theory Course – BT601	100	4

**Semester – I**  
**Syllabus for B.Sc. Botany (Major)**  
**2014**  
**(Theoretical)**

**Paper – BT 101**

**Full Marks – 100**  
**Total Lectures – 56 Periods**  
**(Each Period = 1 hour)**

**Unit – I : (Fundamental Botany)**

**14 Periods**

- 1.6. Origin of life, Difference between plant and animal cell. Time line of plant evolution.
- 1.7. Three domains of classification – Archaea, Bacteria, Eukarya.
- 1.8. History of Plant classification: Natural (Bentham & Hooker), Artificial (Linnaeus) and Phylogenetic (Hutchinson) system of Classification.
- 1.9. Plant life cycle pattern & alternation of generation.
- 1.10. Darwin's theory of evolution, Macro & micro evolution.
- 1.11. Species concept, Isolation & mechanism of speciation.

**Unit – II : (Environmental Botany)**

**14 Periods**

- 2.1. Pollution : Definition and categories
- 2.2. Air pollution : Types and sources of air pollutants and their effects on plants and animals.
- 2.3. Water pollution : Types and sources of pollutants and their effects on plants and animals.
- 2.4. Soil pollution : Sources of pollutants and their effects on living organisms.
- 2.5. Bioremediation, noise pollution, acid rain, classical and photochemical smog, heavy metal pollution and radioactive pollution.
- 2.6. Greenhouse effect and global warming – basic concept; significance of ozone umbrella, ozone hole – types of ozone depleting chemicals and their interactions.

**Unit – III : Industrial Botany – I (Agri Industries and Microbial fermentation, food & Bio-fuels)**

**14 Periods**

- 3.1. Organic farming – Concept, need, types of organic fertilizers, advantages and limitations.
- 3.2. Importance of seed industries, Seed production. Seed processing and marketing, major seed industries & corporation of India.
- 3.3. Production of SCP from algae – *Spirulina* culture technique.
- 3.4. Mushroom production and harvesting (*Volvariella* sp. And *Pleurotus* sp.)
- 3.5. Commercial production of Ethyl alcohol, Citric acid and Penicillin.
- 3.6. Concept of biofuel and its need, Plants used for biofuel production.

**Unit– IV: Industrial Botany– II (Plant Nursery and Floriculture Industry)**

**14 Periods**

- 4.1. Concept and types of nurseries: ornamental plant nursery, fruit plant nursery, medicinal plant nursery, vegetable plant nursery and orchid nursery (with reference to infrastructure required and commercial applications).
- 4.2. Propagation methods: Seed propagation, natural vegetative propagation and artificial vegetative propagation (Cutting: Stem, Layering: Air layering, Grafting: Stone grafting and Approach grafting, Budding: T budding).
- 4.3. Introduction to floriculture: Important floricultural crops, open cultivation practices, harvesting and marketing.

### Suggested Books:

1. **Brodie J and Lewis J (2007).** (Ed.) Unravelling the algae: the past, present and future of algal systematic. CRC press. New York.
2. **Graham L.E. and Wilcox L.W. (2000), Algae.** Penticce – Hall, Inc.
3. **Lee R.E. (2008)** Phycology. Cambridge Univeristy Press.
4. **Das Dutta and Gangulee.** College Botany Vol I, Central Book Depot.
5. **Vashista B.R., Sinha A.K. and Singh V.P. (2005).** Botany for degree studets – Algae, S. Chand's Publication.
6. **Chopra R.N. and Kumar P.K (1998).** Biology of Bryophytes. John Wiley & Sons, New York. NY.
7. **Parihar N.S. (1980).** Bryophytes : An Introduction to Embryophyta. Vol I. Central Book Depot, Allahabad.
8. **Udar R. (1970).** Introduction to Bryophytes, Shashidhar Malaviya Prakashan. Lucknow.
9. **Vashista B.R., Sinha A.K., Kumar A. (2008).** Botany for degree students- Bryophyta, S. Chand's Publication.
10. **Agashe S.N. (1995).** Paleobotany. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
11. **Arnold A.C. (2005).** An Introduction Paleobotany. Agrobios (India), Jodhpur.
12. **Rasid A. (1999).** An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
13. **Sporne K.R. (1986).** The morphology of Pteridophytes. Hutchinson University Library, London.
14. **Stewart W.N. and Rothwell G.W. (2005).** Paleobotany and the Evolution of Plants. 2<sup>nd</sup> Edn. Cambridge University Press.
15. **Vashista B.R, Sinha A.K., Kumar A. (2008).** Botany for degree students – Pteridophyta, S. chand's Publications.
16. **Gangulee and Kar (2006).** College Botany. New Central Book Agency.
17. **Parihar N.S. (1976).** Biology and Morphology of Pteridophytes. Central Book Depot.
18. **Bhatnagar, S.P. and Moitra, A., 1996.** Gymnosperms. New Age Inernational (P) Ltd. Publishers, New Delhi.
19. **Chamberlain, CJ. 1957.** Gymnosperms – Structure and Evolution Amazon.com
20. **Verma and Chopra 1981.** Text book of Gymnosperms; Pradeep Publications.
21. **Jhori, RM, Sneh Lata and Kavia Tyagi, 2012.** A Text book of Gymnosperm. Vedams books. India.
22. **Gurcharan Singh Randhawa and Amitabha Mukhopadhyay.** Floriculture in India. Alhed Publishers.
23. **Debashish Sengupta and Raj Kamal,** Floriculture Marketing in India. Exeel Books.
24. **Floriculture Hand Book,** Eiri, Engineers India Research in Publication.
25. **John Mason.** Nursery Management. John Mason, Landinks Press Publisher.
26. **Plant Nursery Manangement :** How to start and operate a Plant Nursery. Ray.
27. **The complete Book on Organic Farming and Production of Organic Compost.** NPCB Board of Consultants & Engineers. Asia Pacific Business Press Inc.
28. **The Organic Farming Manual: A Comprehensive Guide to Starting and Running a Certified Organic Farm,** Ann Larkin Hansen Storey Publications.
29. **Hand Book of Mushroom Cultivation, Processing and Packaging, Engineers India Research in Publishers.**
30. **Handbook of seed Science and Technology : Seed biology, Production, and Technology.** Amarjit S. Basra, Food Products Press publishers.
31. **N. Kumar 2006.** Breeding of Horticultural crops. New India Publishing house.
32. **D.K. Asthana and M. Asthana.** A Textbook of Environmental Studies. S. Chand and Company Ltd.
33. **T.K. Saha.** Ecology and Environmental Biology. Books and Allied (P) Ltd.

34. **M. C. Dash and S.P. Dash. Fundamental of Ecology.** The Tata Mc Graw – Hill Company.
35. **K.P. Aneja** Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers.
36. **A.K. Joshi and B.D. Singh.** Seed Science and Technology, Kalyani Publishers.
37. **N.C. Singhal.** Seed Science and Technology. Kalyani Publishers.

**Semester – II**  
**Syllabus for B.Sc. Botany (General)**  
**2014**  
**(Theoretical)**

**Paper- BT 201 Full Marks – 50**

**Total Lectures – 33 Periods**  
**(Each Period = 1 Hour)**

**Unit - I: Algae and Bryophyte**

**(16 Periods)**

1. General account: 1.1 Thallus organization, 1.2 Economic importance of algae.
2. Diatom: 2.1 Cell structure, 2.2 Auxospore formation in Centrales and Pennales.
3. Life history: *Oedogonium*, *Chara*, *Ectocarpus* and *Polysiphonia*.
4. General account: 4.1 Origin of Bryophytes, 4.2 Amphibian nature,
5. Life history: Gametophyte structure & reproduction, Development of sporophyte, Spore dispersal of 5.1 *Marchantia*, 5.2 *Anthoceros*, 5.3 *Funaria*.
6. Evolution of sporophyte - Progressive theory.

**Unit – II: Pteridophyta, Gymnosperm & Palaeobotany**

**(17 Periods)**

1. Life history: Sporophyte structure, reproduction and structure of gametophyte of 1.1 *Lycopodium*, 1.2 *Selaginella*, 1.3 *Equisetum*, 1.4 *Pteris*.
2. Telome concept & its significance.
3. Progymnosperm – A brief concept.
4. Life histories – Distribution in India, vegetative and reproductive structure, Development of gametophytes and embryogeny of 4.1. *Cycas*, 4.2 *Pinus* 4.3 *Gnetum*.
5. Plant fossil – 5.1 Types of fossils, 5.2 Different modes of preservation (Schopf – 1975).
6. Importance of fossil study.
7. Geological time scale with dominant plant groups through ages.

**Semester – II**  
**Syllabus for B.Sc. Botany (General)**  
**2014**  
**(Practical)**

**Paper-BT 202      Full marks – 50**

1. Work out on algae .....10 Marks.
2. Work out on Pteridophytes .....10 Marks.
3. Identifications with reasons (2X7) ..... 14 Marks.  
(Algae-I, Bryophyta-2, Pteridophyta –I, Gymnosperm-2, Paleobotany-I)
4. Laboratory Note Book .....8 Marks.
5. *Viva-voce*.....8 Marks.

**PRACTICAL: BT-202P**

- I. To learn use of Simple and Compound Microscopes.

**II. ALGAE & BRYOPHYTES**

1. Work out of the following algae with reproductive structure (Free hand drawing):  
*Oedogonium, Chara, Ectocarpus*.
2. Study of Permanent slides: *Volvox, Polysiphonia*.
3. Morphological study of the plant body (Bryophytes): Genera as mentioned in theoretical syllabus.
4. Study from permanent slides: *Marchantia* (L.S. through gemma cup, antheridiophore, archegoniophore, sporophyte), *Anthoceros* (L.S. of sporophyte), *Funaria* (L.S. of capsule).

**III. PTERIDOPHYTES, GYMNOSPERMS & PALAEOBOTANY**

1. Morphological study of the sporophytic plant body (Pteridophytes): Genera as mentioned in the theoretical syllabus.
2. Workout of the reproductive structures: *Lycopodium, Selaginella, Pteris*.
3. Study from permanent slides: *Psilotum* (T.S. of synangium), *Equisetum* (T.S. of stem-internode, L.S. of strobilus).
4. Morphological study: *Cycas* (microsporophyll and megasporophyll), *Pinus* (female and male cone), *Gnetum* (female and male cone).
5. Study from permanent slides: *Cycas* (L.S. of ovule), L.S. of male and female cone), *Gnetum* (L.S. of male cone and ovule).
6. Study of mega fossils.

**IV. LABORATORY RECORDS**

Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

**Semester – II**  
**Syllabus for B.Sc. Botany (Major)**  
**2014**  
**(Theoretical)**

**Paper BT 201H Full Marks – 60**

**Total Lectures – 48 Periods**  
**(Each Period = 1 Hour)**

**Unit - I : Algae and Bryophyte**

**(23 Periods)**

1. General account : 1.1 Thallus organization, 1.2 Ultra-structure of plastid & flagella, 1.3 Origin & evolution of sex.
2. Outline classification (Lee-1999) up to phylum with characters.
3. Chlorophyceae-Salient features, Life history: *Chlamydomonas*, *Oedogonium*.
4. Charophyceae – Salient features, Life history : *Chara*.
5. Xanthophyceae – Salient features, Life history – *Voucheria*.
6. Bacillariophyceae (Diatom) : 6.1 Cell structure, 6.2 Auxospore formation in Centrales and Pennales.
7. Phaeophyceae – Salient features, Life history – *Ectocarpus*.
8. Rhodophyceae – Salient features, Life history – *Polysiphonia*.
9. Economic importance of algae.
10. General account : 10.1 Origin of Bryophytes, 10.2 Amphibian nature, 10.3 Alteration of generation (Homologous and antithetic theory).
11. Life history : Gametophyte structure & reproduction, Development of sporophyte, Spore dispersal of 11.1 *Riccia*, *Marchantia*, 11.2 *Anthoceros*, *Pellia*, 11.3 *Funaria*.
12. Phyllogeny : 12.1 Evolution of sporophyte (Progressive and regressive theory)
13. Importance of Bryophyta.

**Unit – II : Pteridophyta, Gymnosperm & Palaeobotany**

**(25 Periods)**

1. Life history : Sporophyte structure, reproduction and structure of gametophyte of 1.1 *Psilotum*, 1.2. *Selaginella*, 1.3 *Equisetum*, 1.4, *Pteris*, 1.5. *Marsilea*.
2. Fossil Pteridophytes – Structure and features, Geological distribution & evolutionary significance of 2.1. *Rhynia*, 2.2. *Lepidodendron* (reconstructed) 2.3. *Calamites* (reconstructed) 2.4. *Miadesmia*.
3. Telome concept & its significance.
4. Heterospory and seed habit.
5. Economic importance as food and medicine.
6. Progymnosperm – 6.1 Diagnostic characters, 6.2 Vegetative & reproductive structures of *Archeopteris*.
7. Life histories – Distribution in India, vegetative and reproductive structure, Development of gametophyte and embryogeny of 7.1. *Cycas*, 7.2. *Pinus* 7.3 *Gnetum*.
8. Fossil gymnosperms- Structure and features of 8.1 *Lyginopteris*, 8.2 *Williamsonia*, 8.3 *Cordaites*.
9. Economic importance with reference to wood, resins, essential oils & drugs.
10. Plant fossil – 10.1 Types of fossils, 10.2 Different modes of preservation (Schopf – 1975), 10.3 Conditions favouring fossilization, 10.4 Importance of fossil study.
11. Geological time scale with dominant plant groups through ages.
12. Indian Gondwana system.

**Semester – II**  
**Syllabus for B.Sc. Botany (Major)**  
**2014**  
**(Practical)**

**Paper- BT 202H Full marks – 40**

1. Work out on algae .....8 Marks.
2. Work out on Pteridophytes .....8 Marks.
3. Identifications with reasons .....2x7=14 Marks.  
(Algae-I, Bryophyta-2, Pteridophyta –1, Gymnosperm-2, Paleobotany-I)
4. Laboratory Note Book .....5 Marks.
5. *Viva-voce*.....5 Marks.

**PRACTICAL: BT-202H**

- I. To learn use of Simple and Compound Microscopes.

**II. ALGAE & BRYOPHYTES**

1. Work out of the following algae with reproductive structure (Free hand drawing and drawing under drawing prism with magnification); *Oedogonium*, *Chara*, *Ectocarpus*, *Polysiphonia*.
2. Study of Permanent slides: *Volvox*, *Vaucheria*, *Polysiphonia*.
3. Morphological study of the plant body (Bryophytes): Genera as mentioned in theoretical syllabus.
4. Study from permanent slides: *Riccia* (V.S. of thallus with antheridia/archegonia/sporophyte), *Marchantia* (L.S. through gemma cup, antheridiophore, archegoniophore, sporophyte), *Anthoceros* (L.S. of sporophyte), *Funaria* (L.S. of capsule).

**III. PTERIDOPHYTES, GYMNOSPERMS & PALAEOBOTANY**

1. Morphological study of the sporophytic plant body (Pteridophytes): Genera as mentioned in the theoretical syllabus.
2. Workout of the reproductive structures: *Selaginella*, *Pteris*, *Marsilea*.
3. Study from permanent slides: *Psilotum* (T.S. of synangium), *Lycopodium* (L.S. of strobilus), *Equisetum* (T.S. of stem-internode, L.S. of strobilus).
4. Morphological study: *Cycas* (microsporophyll and megasporophyll), *Pinus* (female and male cone), *Gnetum* (female and male cone).
5. Study from permanent slides: *Cycas* (L.S. of ovule), *Pinus* (L.S. of male and female cone), *Gnetum* (L.S. of male cone and ovule).
6. Study of mega fossils.
7. Study from permanent slides: *Lepidodendron*, *Calamites*, *Lyginopteris*, *Cordaites*, *Glossopteris*.

**IV. LABORATORY RECORDS**

Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

## SEMESTER – III

### Syllabus for B.Sc. Botany (Major)

#### (Theoretical)

**Paper-BT301H**

Full Marks – 60  
(IA – 12, E.S.E. – 48)  
Total Lectures – 30  
(Each Lecture – 1 hr)

#### **Unit I : Fungi and Plant Resource Utilisation**

**15 Periods**

An outline classification of fungi upto class character (Hawksworth – 1995). Economic importance of fungi. Lichens and their significance. Fungal spore form, sexual reproduction and degeneration of sex, Mycotoxins; General account of Phycomycetes, Life history of *Mucor*, *Synchytrium*; General account of Ascomycetes, Life history of *Penicillium*, *Ascobolus*; General account of Basidiomycetes, Life history of *Polyporus*, *Agaricus*; General account of Deuteromycetes, Life history of *Fusarium*, Parasexuality.

Cereal – Rice, Wheat; Pulses – Gram, Moong and Lens; Beverages – Tea and Coffee; Fruits – Mango, Citrus and Papaya; Drug yielding – Cinchona, Rauwolfia, Digitalis and Papver; Spices – Ginger, Cumin and Clove; Oil yielding – Mustard, Groundnut, Coconut and Linseed; Vegetables – Potato, Radish and Cabbage; Fibre yielding – Cotton and Jute; Timber yielding – Teak and Sal; Sugar yielding – Sugarcane and Sugar beet.

Cultivation of Rice, Jute, Rubber and Tea.

#### **Unit II : Microbiology and Plant Pathology**

**15 Periods**

General characteristics of Plant virus and Bacteriophage, Growth cycle (Lytic, T<sub>4</sub> and Lysogenic, λ virus); Bacteria-Cell structure and Endospore formation, Genetic recombination- Conjugation, Transformation and Transduction, Disease concepts, Symptoms-necrotic, hypoplastic and hyperplastic; Necrotrophs and biotrophs, mode of pathogenesis, Defense mechanism with special reference to phytoalexins, Plant quarantine; Koch's postulates, Symptoms, Casual organisms, Disease cycle and Control measures of Late blight of potato, Brown sport of rice, Black stem rust of wheat and Stem rot of Jute.

## **SEMESTER – III**

### **Syllabus for B.Sc. Botany (General)**

#### **(Theoretical)**

**Paper- BT301P**

**Full Marks – 50**  
**(IA – 10, E.S.E. – 40)**  
**Total Lectures – 28**  
**(Each Lecture – 1 hr)**

#### **Unit I : Fungi and Plant Resource Utilisation**

**14 Periods**

An outline classification of fungi upto class character (Hawksworth – 1995). Economic importance of fungi. Lichens and their significance. General account of Phycomycetes, Life history of *Mucor*, *Synctitricum*; General account of Ascomycetes, Life history study of *Penicillium*; General account of Basidiomycetes, Life history of *Polyporus*; General account of Deuteromycetes, Life history study of *Fusarium*.

Cereal – Rice, Wheat; Pulses – Gram, Moong and Lens; Beverages – Tea and Coffee; Fruits – Mango, Citrus and Papaya; Drug yielding– Cinchona, Rauwolfia, Digitalis and Papaver; Spices– Ginger, Cumin and Clove; Oil yielding– Mustard, Groundnut, Coconut and Linseed; Vegetables– Potato, Radish and Cabbage; Fibre yielding– Cotton and Jute; Timber yielding– Teak and Sal; Sugar yielding – Sugarcane and Sugar beet.

Cultivation of Rice, Jute, Rubber and Tea.

#### **Unit II : Microbiology and Plant pathology**

**14 Periods**

General characteristics of Plant Virus and Bacteriophage, Growth cycle- Lytic (T<sub>4</sub>) and Lysogenic ( $\lambda$  virus); Bacteria- Cell structure and Endospore formation, Genetic recombination- Conjugation, Transformation and Transduction; Symptoms-necrotic, hypoplastic and hyperplastic; Koch's postulates, Symptoms, Casual organisms, Disease cycle and Control measures of Late blight of potato, Brown sport of rice and Black stem rust of wheat.

**Semester – III**  
**Syllabus for B.Sc. Botany (Major)**  
**2014**  
**(Practical)**

**Time : 3hrs**

**Full Marks – 40**  
**(IA-08, E.S.E.-32)**

1. Work out on fungi (including measurement .....07
2. Work out on microbiology .....07
3. Identification with reasons .....(5x2)=10
  - a) Plant resource utilization .....2 specimens
  - b) Plant disease .....2 specimens
  - c) Fungi/Microbiology .....1 specimen
4. Laboratory note book with submission .....(3+1)=04
5. *Viva-voce* .....04

**Practical – BT302H**

1. Work out of the following fungi with reproductive structures (including microscopic measurement of reproductive structures) *Mucor*, *Ascobolus*, *Penicillium*, *Agaricus*, *Puccinia*, *Polyporus*.
2. Study from permanent slides: Zygosporangium of *Mucor*. Conidiophore of *Penicillium*, Conidia of *Fusarium*.
3. Preparation of bacterial media – (a) Nutrient agar and nutrient broth, (b) Preparation of slants and pouring Petriplates.
4. Sub-culturing of bacterial/fungal culture.
5. Microscopic examination of bacteria from natural habitat (curd) by Gram staining.
6. Preparation of fungal media (PDA).
7. Sterilization process.
8. Inoculation of pathogen from diseased leaf.
9. Identification: Pathological specimens of Brown spot of rice. Loose smut of wheat. Stem rot of jute, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of *Puccinia graminis*.

**Semester – III**  
**Syllabus for B.Sc. Botany (General)**  
**2014**  
**(Practical)**

**Time : 3hrs**

**Full Marks – 40**  
**(IA-10, E.S.E.-40)**

1. Work out on fungi (including measurement) .....07
2. Work out on microbiology .....07
3. Identification with reasons .....(6x2)=12
  - a) Plant resource utilization .....2 specimens
  - b) Plant disease .....2 specimens
  - c) Fungi/Microbiology .....2 specimens
4. Laboratory note book with submission .....(3+1)=04
5. *Viva-voce* .....04

**Practical – BT302H**

1. Work out of the following fungi with reproductive structures (excluding microscopic measurement of reproductive structures) *Mucor*, *Penicillium*, *Polyporus*.
2. Study from permanent slides: Zygosporangium of *Mucor*. Conidiophore of *Penicillium*, Conidia of *Fusarium*.
3. Microscopic examination of bacteria from natural habitat (curd) by Gram staining.
4. Preparation of fungal media (PDA).
5. Sterilization process.
6. Identification: Pathological specimens of Brown spot of rice. Loose smut of wheat, Stem rot of jute. Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of *Puccinia graminis*.

**Semester-IV**  
**Syllabus for B.Sc. Botany (Major)**  
**(Theoretical)**

**Paper-BT401H**

**Full marks-60**  
**(IA-12, F.S.F. - 48)**  
**Total Lectures – 28**  
**(Each Lecture- 1hr)**

**Unit I: Morphology and Embryology, Taxonomy**

**14 Periods**

Morphology- Inflorescence- types with examples, flower types, floral parts- calyx, corolla (Forms and aestivation), stamens (cohesion and adhesion), carpel (Apocarpous and Syncarpous), Placentation types, fertilization process; Fruits- types; Taxonomy - Nomenclature and rules of ICBN, Magnoliaceae, Poaceae, Orchidaceae, Mimosaceae, Caesalpiniaceae, Fabaceae, Malvaceae, Brassicaceae, Solanaceae, Apocynaceae, Lamiaceae, Rubiaceae and Asteraceae; Embryology- Micro and mega sporogenesis (Monosporic, bisporic and tetrasporic) Development of embryo, development of endosperm.

**Unit II: Anatomy, Ecology and Phytogeography**

**14 Periods**

Anatomy-Cell wall (Gross structure and chemical composition), Meristematic and Permanent tissue (structure, distribution and function); Vascular bundles- types, stele- types and evolution, Normal secondary growth; Anomalous secondary growth (Stems of *Boerhaavia*, *Chenopodium*, *Mirabilis*, *Bignonia*, *Nyctanthes*, Root of *Tinospora*); Ecology. Habitat and Niche (preliminary idea), Ecological succession- Hydrosere and Xerosere, Endemism, Ecological adaptation - Hydrophytes and xerophytes, Red Data Book; Ecological adaptation of Halophytes; Phytogeography- Phytogeographical regions of India (D. Chatterjee-1960); Vegetation of Western and Eastern Himalaya, Sundarban and Tripura.

**Semester IV**  
**Syllabus for B.Sc. Botany (General)**  
**(Theoretical)**

Paper-BT401P

Full marks-50  
(IA-10, E.S.E.40)  
Total Lectures – 24  
(Each Lecture- 1 hr)

**Unit I: Morphology and Taxonomy**

**12 Periods**

Morphology- Inflorescence- types with examples, flower types, floral parts- calyx, corolla (Forms and aestivation), stamens (cohesion and adhesion), carpel (Apocarpous and Syncarpous). Placentation types, fertilization process; Fruits-types: Taxonomy- Magnoliaceae, Poaceae, Orchidaceae, Mimosaceae, Caesalpiniaceae, Fabaceae, Malvaceae. Brassicaceae, Solanaceae, Apocynaceae, Lamiaceae, Rubiaceae and Asteraceae.

**Unit 11: Anatomy, Ecology and Phytogeography**

**12 Periods**

Anatomy-Cell wall (Gross structure and chemical composition), Meristematic and Permanent tissue (structure, distribution and function), Vascular bundles- types, stele-types and evolution, Normal secondary growth; Ecology- Habitat and Niche (preliminary idea), Ecological succession- Hydrosere and Xerosere, Endemism, Red Data Book; Phytogeography- Phytogeographical regions of India (D. Chatterjee-1960): Vegetation of Western and Eastern Himalaya and Tripura.

**Semester IV**  
**Syllabus for B.Sc. Botany (Major)**  
**2014 (Practical)**

Time: 3 hrs

Total marks-40  
(1A-08, E.S.E-32)

1. Work out on Angiosperm.....	08
2. Work out on Anatomy.....	06
3. Spotting (2 no.).....	03
4. Identification with reasons.....	(1x4)= 04
(Morphology-1, Ecology-2, Embryology /Anatomy-1)	
5. Lab notebook and herbarium.....	(2+2) = 04
6. Field record .....	03
7. <i>Viva voce</i> .....	04

**Practical - BT402H**

1. Work out on angiospermic plants- specimens to be selected from the families included in the BT 401 theory paper.
2. Study of anomalous secondary structures with double staining- *Boerhaavia*, *Bignonia*, *Chenopodium*, *Nyctanthes*, Root of *Tinospora*.
3. Identification  
Microscopic study of anatomy: types of stomata, sclerides, types of Raphides, Cystolith, laticiferous duct, Aleurone grain.
4. Identification with reasons:
  - a) Morphology
    - i) Special types of inflorescence
    - ii) Types of stamens
    - iii) Types of Placentation
    - iv) Fruits- types
  - b) Study of adaptive anatomical features - *Nymphaea* petiole, *Nerium* leaf
  - c) Embryology - Stages of Embryo
5. At least 25 herbarium sheets must be submitted.
6. Students are required to go for at least 2 field study tours.

**Semester IV**  
**Syllabus for B.Sc. Botany (General)**  
**2014**  
**(Practical)**

**Time: 3 hrs**

Total marks-50  
(1A-10, E.S.E-40)

1. Work out on Angiosperm.....	10
2. Work out on Anatomy.....	06
3. Spotting identification.....	03
4. Identification with reasons..... (Morphology/Embryology Anatomy-3, Ecology-2)	(4x2) = 08
5. Lab notebook and herbarium.....	(3+3) = 06
6. Field record .....	03
7. <i>Viva voce</i> .....	04

**Practical - BT 402 P**

1. Work out on angiospermic plants- specimens to be selected from the families included in the theory paper.
2. Study of primary structures- Monocot stem, Dicot stem, Dorsiventral leaf, Isobilateral leaf, Monocot root, Dicot root.
3. Identification
  - a) Morphology
    - i) Types of Placentation
    - ii) Types of fruits
  - b) Types of stomata, Raphides, Cystolith and Starch grain.
  - c) Adaptive anatomical features of *Nymphaea* petiole and *Nerium* leaf.
4. At least 15 herbarium sheets must be submitted.
5. Students are required to go for at least 1 field study tours.

## SUGGESTED READINGS

1. Angiosperm Phylogeny Group 2003. An Update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants. APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Crawford, D.J. 2003. Plant Molecular Systematics. Cambridge University Press. Cambridge, UK.
3. Cronquist, A. (1981). An integrated system of Classification of Flowering Plants. Columbia University Press. New York.
4. Hollingsworth P.M., Bateman, R.M., and Gornall, R.J. 1999. Molecular Systematics of Plant Evolution. Taylor and Francis, London.
5. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. 2008. Plant Systematics- A Phylogenetic Approach. Sinauer Associates Inc. Massachusetts, USA.
6. Simpson, M.C. 2006. Plant Systematics. Elsevier, Amsterdam.
7. Stussy, T.F. 1990. Plant Taxonomy, Columbia University Press, USA.
8. Singh, V. and Jain, D.K. Taxonomy of Angiosperms. Rastogi Publication, Meerut 2.
9. Pandey, B.P., Angiosperms- Taxonomy, Embryology and Anatomy, S. Chand and Co., New Delhi.
10. Raghavan, V. 2000. Developmental Biology of Flowering Plants. Springer, Netherlands.
11. Raghavan, V. 1997. Molecular embryology of flowering plants. Cambridge University Press.
12. Shivanna, K.R. 2003. Pollen Biology and Biotechnology. Science Publishers.
13. Bhojwani, S.S. and Bhatnagar, S.P. 2004. The Embryology of Angiosperms. Vikas Publishing House.
14. Johri, B.M. 1984. Embryology of Angiosperms. Springer- Verlag, Netherlands.
15. Dickinson, W.C. 2000. Integrative Plant Anatomy. Harcourt Academic Press. USA.
16. Fahn, A. 1974. Plant Anatomy. Pergamon Press, USA and UK.
17. Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/ Cummings Publisher, USA.
18. Esau, K. 1977. Anatomy of Seed Plants. Wiley Publishers.
19. Sharma, P.D. 2009. Ecology and Environment, (10<sup>th</sup> revised Ed.) Rastogi Pub. FIP, Patparganj, New Delhi- 92.
20. Edward, J. Kormondy, 2008. Concepts of Ecology (4<sup>th</sup> Ed, 2008) Pearson Education Inc. & Dorling Kindersley Pub. Inc. Capital offset Press, New Delhi.
21. Smith, T.M. and Smith, R.L. 2008. Elements of Ecology, Benjamin- Cummings, N.Y. (7<sup>th</sup> Edn.)
22. Miller, G.T., 2004. Essentials of Ecology, Brooks, Cole, N.Y. (3<sup>rd</sup> Edn.)
23. Odum and Barrett, Thomson, Ed. Brooks/ Cole, Fundamentals of Ecology, Cengage Learning.
24. Singh, Singh and Gupta Ed., Ecology, Environment and Resources Conservation, Anamaya Pub., New Delhi.
25. Odum, E.P., Basic Ecology, Ed. Saunders College Pub.

### Marks Distribution of Vth Semester (Elective)

<b>Semester</b>	<b>Theoretical Marks</b>	<b>Practical Marks</b>	<b>Total Marks</b>
Semester- V	50 (IA-10 + ES- 40)	50 (IA-10 + ES- 40)	100

\*IA= Internal Assessment; ES= End Semester Examination

### Course Structure, Vth Semester (Elective)

<b>Course Title</b>	<b>Full Marks</b>
BT 501 (Theory) (Cell and Molecular Biology, Cytogenetics and Plant Breeding, Plant Physiology and Plant Biotechnology)	50
BT 502 (Practical) Based on Theory Course- BT 501	50

## SEMESTER – V

**BT – 501 (Theory) Marks : 100 (Elective)**

**Internal Assessment: 10**

**40 Periods**

**End Semester Examination : 40**

**20 Periods**

### **Unit – I : Cell and Molecular Biology, Cytogenetics and Plant Breeding**

Cell cycle and Cell division, Structure and function of Cell Organelles (Nucleus, Mitochondria, Chloroplast, Ribosome), Chromosome morphology and Organization of eukaryotic Chromosome (Nucleosome concept); Structure, forms and salient features of Nucleic Acids (DNA and RNA); DNA replication, Mechanism of DNA replication in Prokaryotes, Transcription: Initiation, elongation and termination in Prokaryotes. Translation in Prokaryotes: Amino-acylation of tRNA, initiation, elongation and termination of polypeptide chain; Gene Mutation: Transition, Transversion and Frame shift mutation, Lac Operon (brief idea).

Mendelian inheritance; Gene interactions: Incomplete Dominance (1:2:1), Modified dihybrid ratio (12:3:1, 9:3:4, 9:7), Crossing Over: Cytological proof of crossing over (McClintock's experiment); Complete and incomplete linkage; Aneuploidy and Euploidy, role of polyploidy in crop improvement; Chromosomal aberration: deletion, duplication, translocation and inversion; Methods of plant breeding: Introduction, emasculation, Hybridization and Acclimatization; Selection: Mass selection and pure selection; Male sterility: Genetic, Cytoplasmic and Cytoplasmic-genetic male sterility; Heterosis and hybrid vigour;

### **Unit – II: Plant Physiology and Plant Biotechnology**

**20 Periods**

Water potential and its components; Water absorption by roots (apoplastic and symplastic pathways); Photosynthesis: photochemical reactions, Mechanism of electron transport in PS-I and PS-II, Calvin cycle; C<sub>3</sub> and C<sub>4</sub> plants and photosynthetic efficiency, photorespiration, Crassulacean acid metabolism (CAM); Transpiration and anti-transpirant. Respiration: Glycolysis, Oxidative Phosphorylation, Mitochondrial ETS; N-metabolism: Assimilation of Nitrogen, Biological Nitrogen fixation: role of nitrogenase in N<sub>2</sub> fixation; Photoperiodism: Photoperiodic responses and classification of plants, Photomorphogenesis; Plant growth regulators, physiological role and modes of action (IAA, Gibberellins and Cytokinins).

Totipotency and concept of plant tissue culture, Function and organization of a typical plant tissue culture laboratory: Techniques of plant tissue culture: cell suspension culture technique, protoplast culture technique: Modes of *in vitro* regeneration and applications, Callus culture and applications: Haploid and embryo culture; Transformation: *Agrobacterium* mediated gene transfer.

**Semester – V**  
**Practical Paper – 502**  
**Full Marks : 50**

**Internal Assessment : 10**

**End Semester Examination : 40**

1. Mitotic Study : Temporary preparation of metaphase chromosomes from root tips of *Allium cepa*.
2. Identification with reasons from permanent slides: Different stages of mitosis and meiosis including abnormalities like Sticky Bridge, laggard chromosome(s), chromosomal fragmentation, ring chromosome, early separation.
3. Study of pollen sterility by Aceto-carmin staining technique.
4. Detection of organic acids: citric, tartaric, oxalic and malic acids from unknown samples.
5. Detection of the nature of carbohydrate: glucose, fructose and sucrose from unknown samples.
6. Determination of released oxygen during photosynthesis.
7. To extract and separate chlorophyll pigment by chromatography.
8. Relationship between transpiration and evaporation.
9. Measurement of oxygen uptake by respiring tissue (per g/hr).
10. Effect of temperature on absorption of water by storage tissue and determination of  $Q_{10}$ .
11. Comparison of imbibitions of water by starchy, proteinaceous and fatty seeds.
12. Demonstration and function of autoclave, laminar airflow, pH meter and culture room.
13. Aseptic techniques of explants culture.

**Laboratory records:**

1. Laboratory note book of each section must be signed by the respective teacher with date during practical classes.

**Semester – V**  
**Practical – Paper 502**

**End Semester Examination – 40**

**Question Pattern:**

- |    |   |          |
|----|---|----------|
| 1. | Mitotic Study: Temporary preparation of metaphase chromosomes from root tips of material provided.                  | 08       |
| 2. | Identification with reasons (any two –Identification– 1, Reasons– 1)  | (2x2)=04 |
| 3. | Experiment on biochemical works as per practical workout.   | 05       |
| 4. | To perform a major physiological experiment from the list of the experiments as per contents of practical syllabus. | 10       |
| 4. | Demonstration on Plant tissue culture technique.  | 05       |
| 6. | Practical Note Book.  | 04       |
| 7. | <i>Viva voce</i>  | 04       |

### Marks Distribution of Vth & VIth Semester (Major)

Semester	Theoretical Marks	Practical Marks	Total Marks
Semester- V	100 (IA-20+ ES-80)	100 (IA-20+ ES-80)	200
Semester- VI	100 (IA-20+ ES-80)	100 (IA-20+ ES-80)	200
Total	200	200	400

\***IA**= Internal Assessment; \***ES**= End Semester Examination

### Course Structure, Vth & VIth Semester (Major)

Course Title	Full Marks
BT- 501 (Theory) (Cell Biology, Molecular Biology, Cytogenetics, Plant breeding and Biostatistics)	100
BT- 502 (Practical) Based on Theory Course- BT 501	100
BT- 601 (Theory) (Biochemistry, Plant Physiology, Pharmacognosy, Plant Biotechnology)	100
BT- 602 (Practical) Based on Theory Course- BT 601	100

**SEMESTER – V (MAJOR)**  
**BT – 501 (Theory) Marks: 100**

**Internal Assessment: 20**

**56 Periods**

**End Semester Examination: 80**

**Unit – I: Cell Biology**

**14 Periods**

Cell cycle and Cell division, equational and reductional division with respect to 'C' value, Cell cycle regulation, Theories of anaphasic movement; Structure and function of Cell Organelles (Nucleus, Mitochondria, Chloroplast, ER, Golgi Apparatus, Peroxisomes and Glyoxysomes, Ultra-structure of ribosome in Prokaryotes and Eukaryotes) Plasma membrane– Structure (Fluid mosaic model) and function; Chromosome morphology and Organization of Eukaryotic Chromosome (Nucleosome concept); Centromere and telomere – structure and function; Organization of cp and mt DNA and their significance; Apoptosis.

**Unit – II :Molecular Biology**

**14 Periods**

Structure, forms and salient features of Nucleic Acids (DNA and RNA); DNA replication – Semi-conservative replication in Prokaryotes with proof (Meselson and Stahl's Experiment), Mechanism of DNA replication in Prokaryotes, Genetic code: Properties, deciphering of genetic code; Transcription: Initiation, elongation and termination in Prokaryotes. Translation in Prokaryotes: Amino-acylation of RNA, initiation, elongation and termination of polypeptide chain; Gene Mutation: Transition, Transversion and Frame shift mutation, Effects of chemical mutagens (Base analogues and Nitrous acid) Physical agents (UV rays); DNA damage and repair, Concept of Lac Operon (Positive and Negative control). Restriction enzymes: types and function; PCR and its application (A brief idea).

**Unit – III: Cytogenetics**

**14 Periods**

Mendelian inheritance; Gene interactions: Incomplete Dominance (1:2:1), Modified dihybrid ratio (12:3:1, 9:3:4, 9:7, 9:6:1, 13:3), Atavism, Pleiotropism; Polygenic inheritance in plant (15:1); Crossing Over: Cytological proof of crossing over (McClintock's experiment); Molecular basis of Crossing Over; Complete and incomplete linkage, Thee point test cross, Problems on Gene Mapping; Sex linked trait and sex linked inheritance; Aneuploidy and Euploidy, role of polyploidy in crop improvement; Chromosomal aberration: Types and meiotic behavior of deletion, duplication, translocation and inversion; Molecular mapping – FISH technique; Bioinformatics: Genomics and proteomics (A brief idea).

**Unit – IV: Plant Breeding and Biostatistics**

**14 Periods**

Methods of plant breeding: Introduction, emasculation, Hybridization and Acclimatization; Selection: Mass selection and pure selection; Male sterility: Genetic, Cytoplasmic and Cytoplasmic-genetic male sterility; Heterosis and hybrid vigour; Collection of data (Variable and attribute, Primary and Secondary data, Population and sample); Types of charts and diagrams: Frequency distribution (Simple, Grouped and Cumulative); Measures of Central tendency: Mean Mode and Median; Measure of dispersion: Mean deviation and Standard Deviation; Standard Error; Correlation and Coefficient of Correlation (r); Student t-test; Chi Square test for goodness of fit; Classical definition of Probability, Addition and Multiplication rules.

**Pattern of Question Setting  
(Major)  
BT-501 & BT-601**

1. Short Questions 10 marks – Compulsory

From the rest of 70 marks, there would 2 questions of 14 marks each from each unit, Candidate will answer any five questions taking at least one from each unit.

Each a unit of 14 marks may be subdivided into 2 to 3 parts having a maximum of eight marks for a part.

**Semester – V**  
**Practical Paper – 502**  
**Full Marks : 100**

**Internal Assessment : 20**

**End Semester Examination : 80**

1. Mitotic Study : Temporary preparation of metaphase chromosomes from root tips of *Allium cepa* and *Lens esculenta* and determination of their somatic chromosome number.
2. Study of mitotic index in *Allium cepa* L.
3. Meiotic Study : Temporary preparation of prophase I (Diplotene and diakinesis), Metaphase – I and Anaphase – I from flower buds of *Allium cepa*, *Rhoeo sp* and *Datura sp*.
4. Identification with reasons from permanent slides: Different stages of mitosis and meiosis including abnormalities like Sticky Bridge, laggard chromosome(s), chromosomal fragmentation, ring chromosome, early separation.
5. Study of pollen sterility by Aceto-carmin staining technique.
6. Demonstration of emasculation technique.
7. Graphical representation of statistical Data.
8. Statistical analysis of Mean, Mode, Median, Standard deviation, Standard error and T-Test.
9. Determination of goodness of fit in normal and modified dihybrid ratios.

**Laboratory records:**

1. Laboratory note book of each section must be signed by the respective teacher with date during practical classes.

**Semester – V**  
**Practical – Paper 502**

**End Semester Examination – 80**

1. Mitotic Study: Temporary preparation of metaphase chromosomes from root tips of material provided and determination of their somatic chromosome number. 16
2. Study of mitotic index in *Allium cepa* L. 10  
Or  
Temporary preparation of meiosis from the supplied material (Any one stage from the suggested practical works) 10
3. Identification with reasons (any three –Identification – 1, Reasons – 2) (3x3)=9
4. Study of pollen sterility by Aceto-carmin staining technique. 10  
Or  
Demonstration of emasculation technique 10
5. Statistical analysis of the experimental data as included in the syllabus. 15
6. Practical Note Book and Submission of permanent cytological slides. (7+3)=10
7. *Viva voce.* 10

**BT – 601 (Theory) Marks: 100 (Major)**

**SEMESTER – VI**

**Internal Assessment: 20**

**56 Periods**

**End Semester Examination: 80**

**Unit – I: Biochemistry**

**14 Periods**

Structure and properties of water, co-valent and non-covalent bonds, hydrogen bonds, Vander Waal's forces, pH, buffer and isoelectric points; Carbohydrate: Classification, structure and properties; Lipids: Classification and function; Protein: Classification and structure (Primary, Secondary, Tertiary and Quaternary structure); Amino acids: Structure, charge and polarity; essential amino-acids; Enzyme: Classification and function, Isozymes, Allosteric enzymes and Coenzymes; Glycolysis, conversion of pyruvic acid to Acetyl Co-A, TCA cycle; Membrane chemistry, transport and mechanism of ion uptake; Signal transduction pathway and second messenger concept-G protein.

**Plant physiology:**

**14 Periods**

Water potential and its components; Water absorption by roots (apoplastic and symplastic pathways); Photosynthesis: Components of photosynthesis, Types of chlorophyll and carotenoids and their structures and functions; Red drop effect and Enhancement effect, Antenna complex, photochemical reactions, Mechanism of electron transport in PS-I and PS-II, Calvin cycle; HSK pathway; C<sub>3</sub> and C<sub>4</sub> plants and photosynthetic efficiency, photorespiration, Crassulacean acid metabolism (CAM); Stomatal physiology; role of CO<sub>2</sub> ions, ABA and light, transpiration and anti-transpirant. Respiration: Oxidative Phosphorylation, Mitochondrial ETS and uncouplers, PP pathway; N-metabolism: Assimilation of Nitrogen, Biological Nitrogen fixation: symbiotic fixation; 'nod' genes and 'nif' genes, role of nitrogenase in N<sub>2</sub> fixation; Photoperiodism: Photoperiodic responses and classification of plants, Circadian Clock Photomorphogenesis; Phytochromes as photoreceptor in Photoperiodism, Vernalization, Florigen and transition to flowering; Plant growth regulators, physiological role and modes of action (IAA, Gibberellins and Cytokinins), Brassinosteroids, polyamines.

**Unit – III: Pharmacognosy:**

**14 Periods**

Importance of pharmacognosy in modern medicine; Drugs: crude and commercial drugs; Method of commercial drug production, drug adulteration; Classification and evaluation of drugs: organoleptic, microscopic, chemical and physical evaluation; Secondary metabolites and secondary metabolic biosynthetic pathways; Major types of secondary metabolites with source plants: Flavonoids, steroids, terpenoids, resins, phenolics and alkaloids; Organoleptic study of whole plant of *Andrographis paniculata*, Bark of *Alstonia* sp., Rhizome of Ginger, Tuber of *Dioscoria* sp., Leaves of *Adhatoda* sp.

**Unit – IV: Plant Biotechnology**

**14 Periods**

Totipotency and concept of plant tissue culture; Function and organization of a typical plant tissue culture laboratory; Techniques of plant tissue culture: cell suspension culture technique, protoplast culture technique, Meristem tip culture technique; Modes of *in vitro* regeneration and applications; *In vitro* exudation and remedial Measures; Callus culture and applications; Haploid and embryo culture; Prokaryotic vector system and marker genes; Transformation: *Agrobacterium* mediated gene transfer, Particle Bombardment method.

**Practical BT – 602 (H)**  
**Full Marks – 100**

**Internal Assessment: 20**  
**End Semester Examination: 80**

**Section: A**

1. Detection of organic acids: citric, tartaric, oxalic and malic acids from unknown samples.
2. Detection of the nature of carbohydrate: glucose, fructose, sucrose and starch from unknown samples.
3. Detection of Ca, Mg, Fe and S from plant ash sample.
4. Estimation of acidity from lemon by titration method.
5. Colorimetric estimation of protein by Folin phenol reagent.

**Section: B**

6. Estimation of Catalase activity in plant samples.
7. Effect of CO<sub>2</sub> on the rate of photosynthesis.
8. To extract and separate chlorophyll pigment by chromatogram.
9. Determination of loss of water per stomata per hour.
10. Relationship between transpiration and evaporation.
11. Measurement of oxygen uptake by respiring tissue (per g/hr).
12. Determination of the RQ of germinating seeds.
13. Measurement of osmotic pressure of *Rhoeo* leaf by plasmolytic method.
14. Effect of temperature on absorption of water by storage tissue and determination of Q<sub>10</sub>.
15. Comparison of imbibitions of water by starchy, proteinaceous and fatty seeds.

**Section: C**

16. Study of Palisade ratio and Vein islet no.
17. Chemical tests for Steroids and Alkaloids.
18. Powder microscopy of the plant samples as per contents of the syllabus.

**Section: D**

19. Demonstration and function of autoclave, laminar airflow, pH meter and culture room.
20. Aseptic techniques of explants culture.

**Laboratory records:**

1. Laboratory note book of each section must be signed by the respective teacher with date during practical classes.

**Practical BT – 602**

**Full Marks - 100**

**End Semester Examination: 80**

1.	Experiment on biochemical works as per practical workout (A)	14
2.	To perform a major physiological experiment from the list of the experiments as per contents of practical syllabus (B)	22
3.	Work out on pharmacognosy (C)	12
4.	Demonstration on Plant tissue culture technique (D)	12
5.	Practical Note Book	10
6.	<i>Viva voce</i>	10

## Books and references:

1. Plant Cell Tissue and Organ Culture. O.L. Gamborg and G.C. Phillips. Narosa, 1995. ISBN. 81-7319-1018. New Delhi.
2. Plant T Culture: Basic and Applied. T.B. Jha and B. Ghosh. Universities Press. Pvt. Ltd. ISBN. 81-73714886. Hyderabad.
3. Plant Tissue Culture. M.K. Razdan, Oxford & IBH Pub. LTD. ISBN. 81-2041571-X. New Delhi.
4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6<sup>th</sup> edition. John Wiley & Sons. Inc.
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8<sup>th</sup> edition.
6. Lippincott Williams and Wilkins, Philadelphia.
7. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5<sup>th</sup> edition. ASM. Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
8. Becker, W.M., Kleinsmith, L.J., Hardein. J. and Bertoni, G.P. 2009. The World of the Cell. 7<sup>th</sup> edition Pearson Benjamin Cummings Publishing, San Francisco.
9. Watson, J.D., Baker T.A., Bell, S.P., Gann, A., Levine, M., and Losick, R., 2008. Molecular.
10. Biology of the Gene 6<sup>th</sup> edition. Cold Spring Harbour Lab. Press, Pearson Pub.
11. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts and Peter Walter. 2008. Molecular biology of the Cell, 5<sup>th</sup> ed., Garland science, Taylor & Francis Group, LLC, 270 Madison Avenue, New York NY 10016, USA.
12. B.B. Buchanan, W. Gruissem and R.L. Jones. USA (2000). Biochemistry and Molecular Biology of Plants. Ed. ASPP Press.
13. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
14. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
15. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
16. Russell, P.J. (2009). iGenetics-A Molecular Approach. III Edition. Benjamin Cummings.
17. Glick, B.R., Pastemark, J.J. (2003) Molecular Biotechnology-Principles and Applications of recombinant DNA. ASM Press, Washington.
18. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
19. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis. W.H. Freeman and Co.
20. Gupta, P.K., A Text Book of Cytology, Genetics and Evolution, Rastogi Publication, Meerut.
21. Mukhopadhyay P. (1999): Applied Statistics, New Central Book Agency Pvt. Ltd., Calcutta. 5. Goon A.M., Gupta M.K. and Dasgupta B. (1986): Fundamentals of Statistics, Vol. II, World Press, Calcutta. N.G. Das. Principles of Statistics. Vol I & II.
22. Taize, L & Zeiger, E., 2011, Plant Physiology, Sinauer associates Inc. Publishers, Sunderland, Massachusetts, USA.
23. Hopkins, W.G., Huner, N.P.A., 2011, Introduction to Plant Physiology, Wiley International Edition, John Wiley & Sons, USA.
24. Srivastava, H.S., 2008, Plant Physiology & Biochemistry, Rastogi publications, Meerut, India.
25. Hopkins, W.G., and Hunter, NPA, 2011, Introduction to Plant Physiology, Wiley International Edition, John Wiley & Sons, USA.

27. Srivastava, H.S., 2008, Plant Physiology & Biochemistry, Rastogi publications, Meerut, India.
28. Buchanan, B., Gruissem, W., & Jones, R.L., 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.