

B.Sc. Biotechnology (CBCS) I Semester 2015-16

Core Course B1CT02BT01): Biotechnology I

Introduction to Microbiology

(Credits: Theory-4, Practicals-2)

THEORY

Lectures:40 hours, Tutorials: 10 hours, Additional contact hours: 10 (Seminar, quiz, assignments, group, discussion etc)

Faculty: Dr. Suman Krishania

External Marks: 80

Internal marks: 20

UNIT-I

Bacteriology: Modern systems of classification of bacteria. General features, distribution, cell size, shape and arrangement, structure of bacterial cell capsule, flagella, pilli, cell wall – chemical composition and wall characteristics, plasma membrane, mesosomes, cytoplasm, nucleoids.

15 Credit hours

Unit-II

Virology – virus classification, phylogeny, general features, structure, replication in bacteriophages. Transmission of plant and animal viruses and diseases caused by them.

Viroids, virusoids and prions: general features and diseases caused by them.

15 Credit hours

Unit-III

Mycoplasma – history, ultrastructure, nutrition, classification, phylogeny, reproduction and methods of cultivation. Elementary account of most common human /animals diseases (Pulmonary pneumonia, urethritis) caused by mycoplasma.

Brief account of phytoplasma and important diseases caused by them (Sesame phyllody, little leaf of brinjal, grassy shoot of sugarcane).

10 Credit hours

Unit-IV

Methods in microbiology – microbial cultures, physical conditions for growth , methods for culturing aerobic and anaerobic bacteria. Culture media – selective and differential media nutrient agar, nutrient Broth, enrichment media and other media.

10 Credit hours

Unit-V

Plant-microbe interaction: bacterial (associative symbiont, PGPR, *Rhizobium*, fungal symbiosis-mycorrhiza), symbiotic association (bacteria and fungi, microbe-microbe interactions-symbiosis between algae and fungi : lichens) : Antagonistic interactions – amensalism, competition, parasitic and predation.

10 Credit hours

Lecture Number 1 hour each	Topic	Text/Reference
1	Modern Systems of Classification of Bacteria.	Microbiology, Michael J.Pelczar, JR, Chapter 3, page 37-48. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 18-36
2	General Features of Bacteria	Microbiology, Michael J.Pelczar, Chapter 3, page 37-48. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 18-36
3	Distribution of Bacteria	Microbiology, Michael J.Pelczar, Chapter 3, page 37-48 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 18-36
4	Cell Size of Bacteria	Microbiology, Michael J.Pelczar, Chapter 5, page 73-97. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92

5	Bacteria Arrangement	Microbiology, Michael J.Pelczar, Chapter 5, page 73-97. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari ,Chapter 4, page 53-92
Tutorial 1	Bacteria Flagella	Microbiology, Michael J.Pelczar, Chapter 5, page 73-97. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
Seminar 1	Cell Shape of Bacteria	Microbiology, Michael J.Pelczar, JR, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
6	Structure of Bacterial Cell Capsule	Microbiology, Michael J.Pelczar, JR, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
7	Cell wall – Chemical Composition and Wall Characteristics of Bacteria.	Microbiology, Michael J.Pelczar, JR, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
8	Bacteria Mesosomes	Microbiology, Michael J.Pelczar, JR, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari ,Chapter 4, page 53-92
9	Bacteria Plasma membrane.	Microbiology, Michael J.Pelczar, JR Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
10	Bacteria Cytoplasm.	Microbiology, Michael J.Pelczar, JR, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
11	Bacteria Nucleoids.	Microbiology, Michael J.Pelczar, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and

		D.K.Maheshwari, Chapter 4, page 53-92
Tutorial 2	Bacteria Pilli.	Microbiology, Michael J.Pelczar, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
Seminar 2	Bacteria Cell wall	Microbiology, Michael J.Pelczar, Chapter 5, page 73-97 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 4, page 53-92
12	Virology – Introduction	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
13	Virus Classification	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
14	Virus Phylogeny	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
15	Virus General features	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
16	Replication in Bacteriophages	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
Tutorial 3	Virus Structure.	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
Seminar 3	Replication in Bacteriophages	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
17	Transmission of Plant Viruses	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
18	Transmission of Animal Viruses	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339

19	Diseases caused by Animal Virus	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
20	Viroids; general features and diseases caused by them	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
21	Virusoids; General features and diseases caused by them	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
22	Prions: General features and diseases caused by them.	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
Tutorial 4	Diseases caused by Plant Virus	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
Seminar 4	Transmission of plant Viruses	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 15, page 305-339
23	Mycoplasma–History, Ultrastructure, Nutrition, Classification, Phylogeny.	Microbiology, Michael J.Pelczar ,Chapter 13, page 281-282.. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari Book,Chapter 2, page 29 and lecture notes.
24	Elementary account of most common Human disease (Pulmonary pneumonia, Urethritis) caused by Mycoplasma	Microbiology, Michael J.Pelczar,JR, Book,Chapter 13, page 281-282. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari and D.K.Maheshwari, Chapter 2, page 29 and lecture notes.
25	Elementary account of most common Animal disease (Pulmonary pneumonia, urethritis) caused by Mycoplasma	Microbiology, Michael J.Pelczar,JR, Book,Chapter 13, page 281-282. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 29 and lecture notes.
Tutorial 5	Mycoplasma Reproduction and its methods of Cultivation	Microbiology, Michael J.Pelczar, Chapter 13, page 281-282. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari,Chapter 2, page 29 and lecture notes.
Seminar 5	Elementary account of most	Microbiology, Michael J.Pelczar, Chapter 13,

	common Human /Animal disease (Pulmonary pneumonia, Urethritis) caused by Mycoplasma	page 281-282 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari Book,Chapter 2, page 29 and lecture notes
26	Brief account of Phytoplasma	Microbiology, Michael J.Pelczar, Chapter 13, page 281-282 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 29 and lecture notes.
27	Important diseases caused by Phytoplasma (Sesame phyllody)	Microbiology, Michael J.Pelczar, Chapter 13, page 281-282.. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 29 and lecture notes.
28	Important diseases caused by Phytoplasma (Little leaf of brinjal).	Microbiology, Michael J.Pelczar, Chapter 13, page 281-282. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 29 and lecture notes.
Tutorial 6	Important diseases caused by Phytoplasma (grassy shoot of sugarcane).	Microbiology, Michael J.Pelczar, Chapter 13, page 281-282. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 29 and lecture notes.
Seminar 6	Important diseases caused by Phytoplasma (Little leaf of brinjal).	Microbiology, Michael J.Pelczar, Chapter 13, page 281-282 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 2, page 29 and lecture notes
29	Methods in microbiology – Microbial cultures.	Microbiology, Michael J.Pelczar, Chapter 6, page 106-113. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
30	Methods in microbiology – Physical conditions for growth	Microbiology, Michael J.Pelczar, JR, Chapter 6, page 107. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
31	Methods for culturing Aerobic Bacteria	Microbiology, Michael J.Pelczar, Chapter 6, page 110.

		A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
Tutorial 7	Method for culturing Anaerobic bacteria	Microbiology, Michael J.Pelczar, Chapter 6, page 111 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari and D.K.Maheshwari, Chapter 3, page 37-42
Seminar 7	Microbial cultures	Microbiology, Michael J.Pelczar, Chapter 6, 8, page 106-113,133-144. A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
32	Culture media – Selective media.	Microbiology, Michael J.Pelczar, Chapter 8, page 105 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
33	Culture media – Differential media.	Microbiology, Michael J.Pelczar, Chapter 6, page 105 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
34	Culture Media-Nutrient Agar and Nutrient Broth.	Microbiology, Michael J.Pelczar, Chapter 6, page 104-105 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
Tutorial 8	Culture Media-Enrichment Media and other media	Microbiology, Michael J.Pelczar, Chapter 6, page 106 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
Seminar 8	Culture Media – Nutrient Agar	Microbiology, Michael J.Pelczar, Chapter 6, page 104-105 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 3, page 37-42
35	Plant-Microbe Interaction: Bacterial (Associative symbiont, PGPR)	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557
36	Plant-Microbe Interaction: Bacterial (<i>Rhizobium</i> , Fungal Symbiosis-Mycorrhiza),	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557
37	Symbiotic Association (Bacteria and Fungi)	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557

Tutorial 9	Symbiotic Association (Microbe-Microbe Interactions)	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557
Seminar 9	Plant-Microbe Interaction: Bacterial (<i>Rhizobium</i> , Fungal Symbiosis-Mycorrhiza),	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557
38	Lichens : Lymbiosis between Algae and Fungi	Microbiology, Michael J.Pelczar, Chapter18, page-387 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557
39	Antagonistic Interactions – Amensalism, Competition.	A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557
40	Antagonistic Interactions – Parasitic and Predation.	R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557
Tutorial 10	Open for query	
Seminar 10	Lichens : Symbiosis between Algae and Fungi	Microbiology, Michael J.Pelczar, Chapter18, page 387 A Text Book of Microbiology, R.C.Dubey and D.K.Maheshwari, Chapter 24, page 541-557

For additional information the student may consult following reference books:-

Recommended Books

1. Microbiology. McGraw Hill.
2. Prescott, H. and Klein. 2000. Microbiology. McGraw Hill.
3. Tortora. Microbiology: An Introduction. Pearson Education.
4. Stainer, R.Y., Ingrahm, J.L., Wheelis, M.L. and Painter, P.R. General Microbiology. The MacMillian Press Ltd.
5. Madigan, M.T., Martinko, J.M. and Parker, J. B. Biology of Microorganism. Prentice-Hall.
6. Dubey, R.C. and Maheshwari, D.K. A Text Book of Microbiology. S. Chand and Company.

B.Sc. Biotechnology (CBCS) I Semester 2015-16
Core Course-1 (B1CT01BOT01): Botany I
Biodiversity (Microbes, Algae, Fungi and Archegoniate)

(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 40 hours, Tutorials: 10 hours, Additional contact hours: 10 (Seminar, quiz, assignments, group, discussion etc)

Faculty: Dr. Rajesh Suthar

External Marks: 80

Internal marks: 20

Unit 1: Microbes **(10 Lectures)**

Viruses – Discovery, general structure, replication (general account), Economic importance; Bacteriophage, Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae **(10 Lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae

Unit 3: Fungi **(10 Lectures)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 4: Bryophytes **(10 Lectures)**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 5: Pteridophytes and Gymnosperms **(20 Lectures)**

General characteristics, classification, Early land plants (*Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella* and *Equisetum* (Developmental details not to be included). Heterospory and seed habit, stelar evolution.

General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

Lecture No. 1 h each	Topic	Text/Reference
Unit-1		
1	Viruses – Discovery, general characters	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 33 Pg 219
2	Virus Classification and Nomenclature	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 33 Pg 220
3	Virus – Structure I	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 33 Pg 221
4	Virus – Replication I	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 33 Pg 221
5	Bacteriophage	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 33 Pg 228
6	Bacteria - Discovery, General characteristics	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 31Pg 191-192
7	Bacteria - cell structure	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 31Pg 196
8	Bacteria - Reproduction	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 31Pg 205
9	Bacteria -Economic importance.	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 32Pg 213-217
Tutorial 1	Virus – Economic Importance	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 33 Pg 232
Unit -2		
11.	Algae- General Characters	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 01 Pg 1-18
12	Algae- thallus organization	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 01 Pg 1-

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13	Cell structure of algae	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 01 Pg 1-18
14	Classification of algae	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 01 Pg 19-26
15	Algae-reproduction I	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 01 Pg 1-18
16	Morphology and life-cycles of the following: <i>Nostoc</i> ,	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 05 Pg 38-48
Tutorial 2	Morphology and life-cycles of the following: <i>Chlamydomonas and Oedogonium</i>	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 07&12 Pg 52-54 & 93-100
Seminar 1	Morphology and life-cycles of the following <i>Vaucheria, Fucus</i>	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 14 & 20 Pg 113-118 & 148
Seminar 2	Morphology and life-cycles of the following <i>Polysiphonia</i>	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 25 Pg 178-183
20	Economic importance of algae	A Text Book of Botany- Singh, Pande, Jain Unit- I Chapter 27 Pg 187-191
Unit -3		
21	Fungi- General Characters	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 01 Pg 1-7
22	Fungi –Thallus organization	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 01 Pg 1-7
23	Fungi classification and Nutrition	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 01 Pg 8-12
24	Fungi- reproduction	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 01 Pg 1-7
Tutorial -3	life cycle of <i>Rhizopus</i>	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 08 Pg 52-57
26	life cycle of <i>Penicillium</i>	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 10 Pg 72-75
Seminar-3	life cycle of <i>Alternaria</i>	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 19 Pg

		132
Tutorial -4	life cycle of <i>Puccinia and Agaricus</i>	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 15&16 Pg 109-116 &117&122
Seminar-4	General account of mycorrhiza	Text Book of Microbiology- Dubey and Maheshwari Chapter-31 Pg.853-871
30	Symbiotic Associations-Lichens	A Text Book of Botany- Singh, Pande, Jain Unit- II Chapter 26 Pg 161-168
Unit-4		
31	Bryophytes - General characteristics	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 01 Pg 1-8
32	Bryophytes - adaptations to land habit, Classification	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 01 Pg 1-8
33	Bryophytes-Range of thallus organization	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 01 Pg 1-8
34	Classification (up to family) and morphology, of <i>Marchantia</i>	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 02 Pg 21-32
35	Anatomy of <i>Marchantia</i>	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 02 Pg 21-32
36	Reproduction of <i>Funaria</i>	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 06 Pg 86-97
Tutorial-5	Classification (up to family), morphology, anatomy <i>Funaria</i>	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 06 Pg 86-97
Seminar -5	Reproduction of <i>Funaria</i>	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 06 Pg 86-97
39	Ecology and economic importance of bryophytes with special mention of <i>Sphagnum I</i>	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 05 Pg 75-85
40	Ecology and economic importance of bryophytes with special mention of <i>Sphagnum II</i>	A Text Book of Botany- Singh, Pande, Jain Unit- III Chapter 05 Pg 75-85
Unit -5		
41	General characteristics, classification of Pteridophytes I	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 01 Pg

		1-8
42	General characteristics, classification of Pteridophytes II	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 02 Pg 9-13
43	Rhynia	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 05 Pg 23-24
Tutorial -6	Classification (up to family), morphology, of <i>Selaginella</i>	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 10 Pg 66-79
Seminar -6	Anatomy of <i>Selaginella</i>	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 10 Pg 66-79
Tutorial-7	Reproduction of <i>Selaginella</i>	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 10 Pg 66-79
Seminar-7	Classification (up to family), morphology of <i>Equisetum</i>	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 13 Pg 88-100
Tutorial-8	Anatomy of <i>Equisetum</i>	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 13 Pg 88-100
Seminar-8	Reproduction of <i>Equisetum</i>	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 13 Pg 88-100
50	Heterospory and seed habit	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 21 Pg 180-182
51	Stelar Evolution	A Text Book of Botany- Singh, Pande, Jain Unit- IV Chapter 20 Pg 176-179
52	Gymnosperms- General characters and classification I	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 01&02 Pg 1-10
53	Gymnosperms- General characters and classification II	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 01&02 Pg 1-10
54	Classification (up to family), morphology, of <i>Cycas</i>	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 05 Pg 18-36
Tutorial -9	Anatomy of <i>Cycas</i>	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 05 Pg 18-36
Seminar-9	Reproduction of <i>Cycas</i>	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 05 Pg 18-36

57	Classification (up to family), morphology, <i>Pinus</i> .	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 06 Pg 37-58
Tutorial - 10	Anatomy of <i>Pinus</i>	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 06 Pg 37-58
Seminar-10	Reproduction of <i>Pinus</i> .	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 06 Pg 37-58
60	Gymnosperms - Ecological and economical importance.	A Text Book of Botany- Singh, Pande, Jain Unit- V Chapter 10 Pg 100-105

For additional information the student may consult following reference books:-

Suggested Readings

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