UNIVERSITY OF KALYANI

KALYANI, NADIA

WEST BENGAL, INDIA

PIN-741235

SYLLABUS FOR 4 YEARS (8 SEMESTERS) UNDERGRADUATE COURSE IN BOTANY

AS PER NATIONAL EDUCATION POLICY 2020

(with effect from 2023-2024)

Prepared by: Under Graduate Board of Studies (UGBOS) in Botany; University of Kalyani, Kalyani 741235, West Bengal

UNIVERSITY OF KALYANI

COURSE STRUCTURE FOR 4 YEARS (8 SEMESTERS) UNDERGRADUATE PROGRAM IN BOTANY UNDER NEP 2020 (w.e.f. 2023-2024)

SEMESTER I

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ- CC-T-01	Origin , Life Processes and Diversity of Plant groups	Major (Theory)	4	4	40	15	75
BOT-MJ-CC-P-01	Do	Major (Practical)	2	4	20		
BOT- SEC-T-01	**A.** Biofertilizers OR **B.** Plant Diversity and Human Welfare	Skill Enhancement Course (Theory)	2	2	25	10	45
BOT-SEC-P -01	Do	Skill Enhancement Course (Practical)	1	2	10		
BOT-MI- CC-T-01	Biodiversity of Microbes, Algae, Fungi and Bryophytes	Minor (Theory)	3	3	25	10	50
BOT-MI-CC-P-01	Do	Minor (Practical)	1	2	15		
BOT-MDC-T-01	Plant Diversity And Morphology	Multi Disciplinary Course (Theory)	3	3	35	10	45
VAC	Environmental Education	Value Added Course	4	4	40	10	50
TOTAL			**20**	**24**			**265**

SEMESTER II

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ CC-T-02	Biomolecules And Cell Biology	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC- P-02	Do	Major (Practical)	**2**	**4**	**20**		
BOT- SEC-T- 02	A: Floriculture OR B: Medicinal Botany	Skill Enhancement Course (Theory)	**2**	**2**	**25**	**10**	**45**
BOT- SEC-P- 02	Do	Skill Enhancement Course (Practical)	**1**	**2**	**10**		
BOT-MI- CC-T-01	Biodiversity of Microbes, Algae, Fungi and Bryophytes	Minor (Theory)	**3**	**3**	**25**	**10**	**50**
BOT-MI- CC-P-01	Do	Minor (Practical)	**1**	**2**	**15**		
BOT-MDC-T-01	Plant Diversity and Morphology	Multi Disciplinary Course (Theory)	**3**	**3**	**35**	**10**	**45**
AECC	Communicative English	Ability Enhancement Course	**4**	**4**	**40**	**10**	**50**
		Summer Internship Course	**4**				
TOTAL			**24**	**24**			**265**

SEMESTER III

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ- CC-T-03	Phycology and Lichen.	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-03	Do	Major (Practical)	**2**	**4**	**20**		
BOT- SEC-T- 03	**A.** Mushroom Culture OR **B.** Intellectual Property Rights	Skill Enhancement Course (Theory)	**2**	**2**	**25**	**10**	**45**
BOT- SEC-P- 03	Do	Skill Enhancement Course (Practical)	**1**	**2**	**10**		
BOT-MI-CC- T-02	Vascular Plants, Morphology and Taxonomy of Angiosperms	Minor (Theory)	**3**	**3**	**25**	**10**	**50**
BOT-MI-CC- P-02	Do	Minor (Practical)	**1**	**2**	**15**		
BOT-MDC-T-01	Plant Diversity And Morphology	Multi Disciplinary Course (Theory)	**3**	**3**	**35**	**10**	**45**
VAC		Value Added Course	**4**	**4**	**40**	**10**	**50**
TOTAL			**20**	**24**			**265**

SEMESTER IV

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ- CC-T-04	Bryophytes and Pteridophytes	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-04	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MJ-CC-T-05	Gymnosperm and Palaeobotany	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-05	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MI- CC-T-02	Vascular Plants, Morphology and Taxonomy of Angiosperms	Minor (Theory)	**3**	**3**	**25**	**10**	**50**
BOT-MI -CC-P-02	Do	Minor (Practical)	**1**	**2**	**15**		
AECC		Ability Enhancement Course	**4**	**4**	**40**	**10**	**50**
		Summer Internship Course	**4**				
TOTAL			**24**	**25**			**265**

SEMESTER V

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ- CC-T-06	Plant Systematics, Morphology and Anatomy	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-06	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MJ-CC-T-07	Reproductive Biology of Plants.	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-07	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MI- CC-T-03	Cytogenetics, Anatomy and Embryology	Minor (Theory)	**3**	**3**	**25**	**10**	**50**
BOT-MI-CC-P-03	Do	Minor (Practical)	**1**	**2**	**15**		
MINOR 2	Other Subject		**4**				**50**
		Summer Internship Course	**4**				
TOTAL			**24**				**250**

SEMESTER VI

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ- CC-T-08	Plant Physiology and Biochemistry	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-08	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MJ-CC-T-09	Plant Metabolism	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-09	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MJ-CC-T-10	Genetics, Biometry and Plant Breeding	Major (Theory)	**4**	**3**	**40**	**15**	**75**
BOT-MJ-CC-P-10	Do	Major (Practical)	**2**	**2**	**20**		
	OUTREACH / INTERNSHIP		**2**				
TOTAL			**20**				**225**

SEMESTER VII

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ- CC-T-11	Microbiology and Immunology	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-11	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MJ-CC-T-12	Fungi and Plant Pathology.	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-12	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MJ-CC-T-13	Plant Molecular Biology and Biotechnology	Major (Theory)	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-13	Do	Major (Practical)	**2**	**2**	**20**		
BOT-MI-CC-T 04	Plant physiology and Ecology	Minor	**3**	**3**	**25**	**10**	**50**
BOT-MI-CC-P 04	Do	Minor	**1**	**2**	**15**		
MINOR 2	Other Subject		**4**				**50**
TOTAL			**26**				**325**

SEMESTER VIII

COURSE CODE	COURSE TITLE	NAME OF THE COURSE	CREDIT OF COURSE	CLASS HOURS PER WEEK	EVALUATION	INTERNAL ASSESSMENT	TOTAL
BOT-MJ- CC-T 14	Plant Ecology, Biodiversity and Conservation	Major (Theory)	**3**	**3**	**25**	**10**	**50**
BOT-MJ-CC-P 14	Do	Major (Practical)	**1**	**2**	**15**		
BOT-MJ-CC-T-15	Economic Botany and Pharmacognosy	Major (Theory)	**3**	**3**	**25**	**10**	**50**
BOT-MJ-CC-P 15	Do	Major (Practical)	**1**	**2**	**15**		
BOT-MJ- CC-T-16	Analytical Techniques in Plant Science	Major (Theory)	**3**	**3**	**25**	**10**	**50**
BOT-MJ-CC-P-16	Do	Major (Practical)	**1**	**2**	**15**		
BOT-MJ- CC-T-17	Entrepreneurial Botany	Major (Theory) **Honours without research**	**2**	**2**	**25**	-	**75**
BOT-MJ- CC-P-17	Do	Major (Practical+Project)	**4**	**8**	**50**		
BOT-MJ-CC-T-18	Stress Biology	Major (Theory) **Honours without research**	**4**	**4**	**40**	**15**	**75**
BOT-MJ-CC-P-18	Do	Major (Practical)	**2**	**4**	**20**		
BOT-MJ-PRO-1	Project/Dissertation	Project/Dissertation [**Honours with research**]	**12**	**24**	**150**		**150**
TOTAL			**24**				**250**

B.SC. BOTANY 4 YEARS SYLLABUS

MAJOR

SEMESTER I	BOT-MJ-CC-T & P-01; Origin, Life Processes and Diversity of Plant groups.
SEMESTER II	BOT-MJ-CC-T & P 02; Biomolecules and Cell Biology.
SEMESTER III	BOT-MJ-CC-T& P 03; Phycology and Lichen.
SEMESTER IV	BOT-MJ-CC-T& P 04; Bryophytes and Pteridophytes. BOT-MJ-CC-T& P 05; Gymnosperm and Palaeobotany.
SEMESTER V	BOT-MJ-CC-T& P 06; Plant Systematics, Morphology and Anatomy. BOT-MJ-CC-T& P 07; Reproductive Biology of Plants.
SEMESTER VI	BOT-MJ-CC-T& P 08; Plant Physiology and Biochemistry. BOT-MJ-CC-T& P 09; Plant Metabolism. BOT-MJ-CC-T& P 10; Genetics, Biometry and Plant Breeding.
SEMESTER VII	BOT-MJ-CC-T& P 11; Microbiology and Immunology. BOT-MJ-CC-T& P 12; Fungi and Plant Pathology. BOT-MJ-CC-T& P 13; Plant Molecular Biology and Biotechnology.
SEMESTER VIII	BOT-MJ-CC-T& P 14; Plant Ecology, Biodiversity and Conservation. BOT-MJ-CC-T& P 15; Economic Botany and Pharmacognosy. BOT-MJ-CC-T& P 16; Analytical Techniques in Plant Science. **Honours without research:** [BOT-MJ-CC-T& P 17; Entrepreneurial Botany. BOT-MJ-CC-T& P 18; Stress Biology] **OR** **Honours with research** [Project/Dissertation]

MINOR

SEMESTER I/II	BOT-MI-CC-T & P 01: Biodiversity of Microbes, Algae, Fungi and Bryophytes.
SEMESTER III/IV	BOT-MI-CC-T & P 02: Vascular Plants, Morphology and Taxonomy of Angiosperms.
SEMESTER V	BOT-MI-CC-T& P 03: Cytogenetics, Anatomy and Embryology.
SEMESTER VII	BOT-MI-CC-T& P 04: Plant Physiology and Ecology.

[N.B. : PRACTICAL MARKS DISTRIBUTION:
WORK OUT-6
IDENTIFICATION-1.5X2=3
LABORATORY NOTE BOOK- 3
VIVA VOCE-3]

SEMESTER I-MAJOR

COURSE CODE: BOT-MJ--CC-T-01 (THEORY) & BOT-MJ-CC-P-01 (PRACTICAL)

COURSE TITLE: ORIGIN, LIFE PROCESSESS AND DIVERSITY OF PLANT GROUPS

CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Understand the concept of origin of life, origin of land plant and plant evolution
- Describe general characteristics of viruses, bacteria, algae, fungi and archegoniate with special reference to their classification, morphology, reproduction and ecology.
- Explain their role in environment, human welfare and in industrial applications;
- Apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ-CC-T-01

Unit 1: Origin of Life **(4)**

What is life? Theories of origin of life; Role of water in life process; Origin of land plants.

Unit 2: Microbes **(5)**

Viruses- Discovery, General structure; Economic importance;
Bacteria- Discovery, General characteristics and Cell structure; Economic importance.

Unit 3: Algae **(6)**

General characteristics; Salient features of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae and Bacillariophyceae; Ecology and Distribution of algae; Economic importance of algae.

Unit 4: Fungi **(5)**

Introduction – General characteristics, Salient features of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina; Nutrition and Reproduction; Ecology and significance; Mycorrhiza: Ectomycorrhiza and Endomycorrhiza; Lichens- general account.

Unit 5: Introduction to Archegoniate **(3)**
Unifying features of archegoniates; Transition to land habit; Alternation of generations.

Unit 6: Bryophytes **(5)**
General characteristics, Salient features of Hepaticopsida, Anthocerotopsida and Bryopsida. Adaptation to land habitat; Ecological and Economic importance of Bryophytes.

Unit 7: Pteridophytes **(4)**
General characteristics, Salient features of Psilophyta, Lycophyta, Sphenophyta and Filicophyta; Ecological and Economical importance.

Unit 8: Gymnosperms **(4)**
General characteristics; Salient features of Cycadophyta, Coniferophyta and Gnetophyta; Ecological and Economic importance.

Unit 9: Angiosperms **(4)**
Floral characteristics; Affinity with Gymnosperms; Herbarium; Botanical Garden.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-01

Identification of the following from Preserved or Fresh Specimen/Permanent slides/Phptographs:

1. **Bacterial forms** : Coccus, Bacillus, Spirillum, Vibrio
2. **Algae** : *Nostoc, Lyngbya, Spirogyra, Oedogonium*
3. **Fungi**: *Rhizopus* (Vegetative structure with sporangium/ zygospore)
   Aspergillus (Vegetative structure with conidia)
   Ascobolus (Fruit body, Longitudinal Section of fruit body)
   Agaricus (Fruit body, Longitudinal Section of gills)
4. **Bryophytes**: *Riccia,* (Entire thallus, Transverse Section of thallus showing sporophyte)
   Marchantia (Longitudinal Section of archegoniophore, antheridiophore and sporophyte)
   Funaria, (Plant body, Longitudinal Section of capsule)
5. **Pteridophytes***: Lycopodium* (Plant body, Longitudinal Section of strobilus)
   Pteris (Transverse Section of leaflet).
6. **Gymnosperms:** *Cycas* (External morphology of Megasporophyll and Microsporophyll)
   *Pinus (*Female cone; Longitudinal Section of male and female cone)
7. **Angiosperms**: *Polianthes tuberosa,*
   Crysopogon aciculatus,
   Tridax procumbens,
   Oldenlandia corymbosa,
   Solanum nigrum.

SUGGESTED READINGS/REFERENCES

1. Kumar, H. D.. Introductory Phycology. East West Press Pvt. Ltd., New Delhi 1999.
2. Stanier, R.Y., Ingraham. J.L.,.Wheelis, M.L and Painter P.R.. General Microbiology. International Edition (5th). 1999.
3. Alexopoulos, C.J., Mims, C.W. And Blackwell, M.. Introductory Mycology. John Wiley and Sons (Asia), Singapore. Ed. 4th. 1996.
4. Parihar, N.S. .An Introduction to Embryophyta. Central Book Depot, Allahabad. Vol. I. 1991.
5. Vashishta. P.C., Sinha, A.K. And Kumar, A.. Pteridophyta. S.Chand, Delhi. 2010.
6. Bhatnagar, S. P. and Moitra, A.. Gymnosperms. New Age international Pvt. Ltd., New Delhi,1996.
7. Sachdeva, S. K.. Angiosperm: morphology, anatomy, taxonomy, evolution. Kalyani Publishers, New Delhi, 1990.

BOTANY (SKILL ENHANCEMENT COURSE)

COURSE CODE: BOT-SEC-T-01(THEORY) & BOT-SEC-P-01(PRACTICAL)

COURSE CREDIT- 3 [2(THEORY) +1(PRACTICAL)]

FM=45[25(THEORY) + 10(PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE TITLE: A. BIOFERTILIZERS

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Elucidate different types of fertilizers using biological organisms;
- Apply the knowledge gained in utilization of biofertilizers in organic farming.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-01-A

Unit 1: **(3)**
General account about the microbes used as biofertilizer; *Rhizobium* - isolation. identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 2: **(7)**
Azospirillum: isolation and mass multiplication - carrier based inoculants, associative effect of different microorganisms. *Azotobacter*: classification, characteristics - crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

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

Unit 4: **(7)**
Mycorrhizal association, types of mycorrhizal association, taxonomy, Occurrence and distribution, phosphorus nutrition, growth and yield - colonization of AM - isolation and inoculum production of AM, and its influence on growth and yield of crop plants.

Unit 5: **(5)**
Organic farming - Green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and industrial wastes - biocompost making methods, types and method of vermicomposting- field application.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-SEC-P-01-A

1. Isolation of *Rhizobium* from leguminous root nodule
2. Isolation of *Azotobacter*, *Azospirillum*
3. Isolation of BGA from water and soil samples
4. Production of *Azolla* in trays
5. Study of different types of Mycorrhizal association from permanent slides/photographs
6. Visit to areas where organic farming, bio composting, vermicomposting are practiced

[N.B: MARKS DISTRIBUTION OF SEC PRACTICAL PAPER:

PRACTICAL NOTE BOOK- 3 + FIELD VISIT REPORT-4 AND VIVA VOCE-3]

SUGGESTED READINGS/ REFERENCES:

1. Dubey, R.C. (2005). A Text book of Biotechnology. S. Chand and Co, New Delhi.
2. Kumaresan, V. (2005). Biotechnology, Saras Publications, New Delh.
3. John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 5. Subha Rao, (2004). N.S. Vermiculture and Organic Farming. Daya Publishers.
5. Subha Rao, N.S. (2000). Soil Microbiology, Oxford and IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic farming. Akta, Prakashan, Nadiad.

COURSE TITLE: B. PLANT DIVERSITY AND HUMAN WELFARE

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Explain the concept and value of biodiversity, threats to biodiversity, need for conservation and environmental stewardship;
- Apply and implement conservation strategies for biodiversity management.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-01-B

Unit 1: Plant diversity and its scope **(7)**

Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes

Unit 2: Loss and Management of Biodiversity **(7)**

Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management- Methodology for IUCN, UNEP, UNESCO, WWE, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.

Unit 3: Conservation of Biodiversity **(6)**

Conservation of genetic diversity, species diversity and ecosystem diversity, *in situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes. Sustainable development.

Unit 4: Role of plants in relation to Human Welfare **(5)**

a) Importance of forestry their utilization and commercial aspects, b) Avenue trees, c) Ornamental plants of India, d) Alcoholic beverages through ages, d) Fruits and nuts: Important fruit crops and their commercial importance, e) Wood and its uses.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-SEC-P-01-B

1. Study of plant diversity in urban and rural areas.
2. Visit to a Botanical garden, Herbarium (*ex situ* conservation); National park/Sanctuaries/Biosphere reserve (*in situ* conservation).
3. Identification of some important microbes (*Aspergillus niger*, *Penicillium notatum*, *Lactobacillus* sp., *Saccharomyces* sp., *Chlorella* sp., *Spirulina* sp.) and their uses.

[N.B: MARKS DISTRIBUTION OF SEC PRACTICAL PAPER:

FIELD VISIT REPORT-5
IDENTIFICATION - 2
VIVA VOCE-3]

SUGGESTED READINGS/ REFERENCES:

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
2. Bharucha, Erach. (2005).Textbook of Environmental Studies for Undergraduate Courses. Universities Press.
3. Sharma,P.D.(2019-2020,13th edition).Ecology And Environment. Rastogi Publication.

SEMESTER I/II- MINOR

INSTRUCTION: Candidate may opt either in Semester I & III or Semester II & IV

COURSE CODE: BOT-MI-CC-T-01(THEORY) & BOT-MI-CC-P-01(PRACTICAL)

COURSE TITLE: BIODIVERSITY OF MICROBES, ALGAE, FUNGI AND BRYOPHYTES

COURSE CREDIT: 4 [3(THEORY) + 1(PRACTICAL)]

FULL POINTS: 50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Describe general characteristics of viruses, bacteria, algae, fungi and bryophytes with special reference to their classification, morphology, reproduction.
- Explain their role in environment, human welfare and industrial applications.
- Apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MI-CC-T-01

Unit 1: Microbes (7)

Virus- General structure, Replication (general account), DNA virus (T-phage); Lytic and Lysogenic cycle, RNA virus (TMV); Economic importance;

Bacteria- General characteristics and cell structure; Reproduction- Conjugation, Transformation and Transduction; Economic importance.

Unit 2: Algae (6)

General characteristics; Reproduction; Classification of Algae by Fritsch (1935); Economic importance of algae.

Unit 3: Fungi (6)

Introduction; General characteristics; Cell Wall composition, Reproduction; Classification (Alexopoulos, Mims and Blackwell 1996); Symbiotic Associations- Lichens: General account; Mycorrhiza: Ectomycorrhiza and Endomycorrhiza.

Unit 4: Bryophytes **(6)**

General characteristics; adaptations to land habit; classification following Smith G.M. (1955); Economic importance of bryophytes with special mention of *Sphagnum***.**

COURSE CONTENT (PRACTICAL)
COURSE CODE- BOT–MI-CC-P-01

1. **Viruses- (**Study from Electron Micrographs/Models)-
   T-Phage and TMV.
2. **Types of Bacteria – (**Study from temporary slides/permanent slides/photographs.)
3. **Gram staining.**
4. **Algae-** (Study from permanent slides/ preserved specimen) –
   Nostoc, Oedogonium, Chlamydomonas and *Fucus*
5. **Fungi-** (Study from permanent slides/ preserved specimen)-
   Rhizopus and *Penicillium*, *Agaricus* (Section of gills).
6. **Lichens:** Study of growth forms of Lichens (crustose, foliose and fruticose).
7. **Mycorrhiza**: Ectomycorrhiza and Endomycorrhiza (Photographs).
8. **Bryophyte**-(Study from permanent slides/ preserved specimen)-
   Marchantia (Morphology of thallus, Longitudinal Section of antheridiophore, archegoniophore) , *Funaria (*morphology, longitudinal section of capsule).

SUGGESTED READINGS/REFERENCES:

1. Kumar, H. D.. Introductory Phycology. East West Press Pvt. Ltd., New Delhi 1999.
2. Vashishta B.R., Sinha A.K.. Botany for degree students Fungi. S. Chand
3. Vashishta B.R., Sinha A.K Botany for degree students Bryophyta.. S. Chand Publication.

BOTANY (MULTIDISCIPLINARY COURSE)

(INSTRUCTIONS: Candidates will opt only once either in Semester I, II or III)

COURSE CODE: BOT-MDC-T-01 (THEORY) & BOT-MDC-P-01 (PRACTICAL)

COURSE TITLE: PLANT DIVERSITY AND MORPHOLOGY

COURSE CREDIT= 3 [THEORY]

FULL POINTS = 45 [35(THEORY) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVE:

After completion of the course the learners will be able to:

- Describe general characteristics of viruses, bacteria, algae, fungi, bryophyte, pteridophyte, gymnosperm and angiosperm with special reference to their classification, morphology, reproduction and ecology.
- Explain their role in environment, human welfare and in industrial applications;

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MDC-T-01

1. General characteristics of Virus, Bacteria, Algae, Fungi, Bryophyte, Pteridophyte, Gymnosperm and Angiosperm; economic and ecological importance of the plant groups. **(8)**
2. Morphology of leaves (Types, phyllotaxy, modification of leaves, stipules) **(4)**
3. Morphology of inflorescence (Types and examples). **(2)**
4. Morphology of flower (Parts of flower, types of flowers, modification of calyx, aestivation, floral formula and diagram, adhesion & cohesion of floral parts, types of placentation. **(7)**
5. Morphology of fruits & seeds (Types and dispersal). **(4)**

SUGGESTED READINGS/REFERENCES:

1. Kumar, H. D.. Introductory Phycology. East West Press Pvt. Ltd., New Delhi 1999.
2. Vashishta B.R., Sinha A.K. Botany for degree students Fungi. S. Chand,
3. Vashishta, B.R ., Sinha A.K. Botany for degree students Bryophyta.. S. Chand.
4. Vashishta, P.C., Sinha, A.K. and Kumar, A.. Pteridophyta. S. Chand, Delhi. 2010.
5. Bhatnagar, S. P. and Moitra, A.. Gymnosperms by New Age international Pvt Ltd., New Delhi, 1996.
6. Sachdeva, S. K.. Angiosperm: morphology, anatomy, taxonomy, evolution. Kalyani Publishers, New Delhi, 1990.

SEMESTER-II MAJOR

COURSE CODE: BOT-MJ-CC-T-02 (THEORY) & BOT-MJ-CC-P-02 (PRACTICAL)

COURSE TITLE: BIOMOLECULES AND CELL BIOLOGY

COURSE CREDIT – 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS – 75 [40 (THEORY) +20 (PRACTICAL)+ 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Describe the types, nomenclature and structures of biomolecules;
- Explain the function and structure of cells including their metabolic reactions that occur in cells;
- Elucidate the laws of thermodynamics and translate reaction mechanisms within cells into their final expressions;
- Discuss the origin of eukaryotic cell;
- Explain the process of cell division and inheritance.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-02

Unit 1: Biomolecules (18)

A Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

B. Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and Polysaccharides.

C. Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerol structure, functions and properties; Phosphoglycerides.

D. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.

E. Nucleic acids: Types of nucleic acids; Structure and function of nucleotides; Structure of nitrogenous bases; Types of DNA: A-DNA, B-DNA, Z-DNA; Types of RNA; Structure of t- RNA.

Unit 2: Bioenergetics **(3)**

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule.

Unit 3: Enzymes **(5)**

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), Michaelis – Menten equation, Enzyme Inhibition and factor affecting enzyme activity.

Unit 4: The cell **(2)**

Cell as an unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic Theory).

Unit 5: Cell wall and plasma membrane **(3)**

Chemistry, structure and function of plant cell wall. Overview of membrane function; Fluid Mosaic Model; Chemical composition of membranes; Membrane transport – Passive, Active and Facilitated transport; Endocytosis and Exocytosis.

Unit 6: Cell organelles **(7)**

A. Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.
B. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.
C. Chloroplast, Mitochondrion, and Peroxisome: Structural organization; Function; Semiautonomous nature of mitochondrion and chloroplast.
D. Endomembrane system:
   Endoplasmic Reticulum (ER) – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus;
   Lysosome– structure and function.
E. Organelle without membranes: Ribosomes – structure and function.

Unit 7: Cell division **(2)**

Phases of eukaryotic cell cycle, Mitosis and Meiosis; Regulation of cell cycle- checkpoints, Role of protein kinases.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-02

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of *Allium cepa/ Rhoeo/Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume using haemocytometer (Yeast/pollen grains).

6. Study of cell and its organelles with the help of electron microscopic photograph.
7. Cytochemical staining of DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique (demonstration only).
8. Study the phenomenon of Plasmolysis and Deplasmolysis.
9. Study different stages of Mitosis and Meiosis.

SUGGESTED READINGS/ REFERENCES:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7thedition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Berg J.M., Tymoczko, J.L. and Stryer, L. (2011) Biochemistry, W.H. Freeman and Company.
3. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
4. Campbell, P.N. and Smith A.D. (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.
5. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5thedition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education. Inc. U.S.A. 8th edition.
7. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
8. Nelson, D.L. and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company
9. Tymoczko J.L., Berg J.M. and Stryer L. (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman.

BOTANY (SKILL ENHANCEMENT COURSE COURSE)

COURSE CODE: BOT-SEC-T-02(THEORY) & BOT-SEC-P-02(PRACTICAL)

COURSE CREDIT- 3 [2(THEORY) +1(PRACTICAL)]

FM=45 [25(THEORY) +10 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE TITLE A: FLORICULTURE

COURSE OBJECTIVES:
After completion of the course the learners will be able to:
♣ Apply the assimilated knowledge and skills in production, processing, and distribution of flowers, cut flowers, foliage, and related plant materials;
♣ Prescribe best management practices in field and greenhouse production of flowers and related plant materials and the arrangement of plant materials for ornamental purposes.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-02-A

Unit 1: **(3)**
Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

Unit 2: **(5)**
Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit 3: **(5)**
Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit 4: **(5)**
Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

Unit 5: **(2)**

Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit 6: **(4)**
Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids).

Unit 7: **(1)**
Diseases and Pests of Ornamental Plants.

COURSE CONTENT (PRACTICAL)
COURSE CODE:BOT-SEC-P-02-A

1. Make a comprehensive study about the landscape of your college and your opinion to improve it.
2. Write about the flowering plants in your college campus and your role in maintaining at least five ornamental plants.

[**N.B: MARKS DISTRIBUTION OF SEC PRACTICAL PAPER:**

FIELD REPORT-6
VIVA VOCE-4]

SUGGESTED READINGS/ REFERENCES:

1. Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.

COURSE TITLE B: MEDICINAL BOTANY

COURSE OBJECTIVES:

After completion of the course the learners will be able to:
♣ Discuss the history, scope and importance of plants as sources of medicines;
♣ Describe methods for sustainable utilization of plant herbal resources;
♣ Apply theknowledge gained in utilizing plants used as traditional/ folk medicines and strategize their conservation.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-02-B

Unit 1: History, Scope and Importance of Medicinal Plants **(8)**
Indigenous Medicinal Sciences; Definition and Scope of medicinal plants. Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments. Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 2: Conservation of Endangered and Endemic Medicinal Plants (8)
Definition: endemic and endangered medicinal plants. Red list criteria; *in situ* conservation: Biosphere reserves, Sacred groves, National Parks; *ex situ* conservation: Botanical Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 3: Ethnobotany and Folk medicines (9)
Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin disease.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-SEC-P-02-B

1. Make a field report on the important medicinal plants (at least 10) used by local inhabitants.

[N.B: MARKS DISTRIBUTION OF SEC PRACTICAL PAPER:

FIELD REPORT-6
VIVA VOCE-4]

SUGGESTED READINGS/ REFERENCES:

1. Purohit, S.S. and Vyas, S.P. (2008). Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
2. Trivedi P.C. (2006). Medicinal Plants: Ethnobotanical Approach, Agrobios, India

SEMESTER III-MAJOR

COURSE CODE: BOT-MJ--CC-T-03 (THEORY) & BOT-MJ-CC-P-03 (PRACTICAL)

COURSE TITLE: PHYCOLOGY AND LICHENS

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- To understand the relevance of algae with special to their classification, morphology, reproduction, distribution and ecology;
- Explain their role in environment, human welfare and in industrial applications;
- Apply this knowledge in understanding the evolutionary significance of these organisms.
- To perceive an idea about lichen.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-03

Unit 1: Relevance of studying algae **(7)**
Diversity and Distribution; Range of thallus organization, Ecology; Criteria for classification (cell wall, pigment system, reserve food, flagella); Reproduction and Life cycle patterns; Classification up to groups (Lee, 2008); Algal bloom and Toxin; Evolution of sex.

Unit 2: Cyanophyceae (Blue-Green Algae) **(3)**
Occurrence; Cell structure; Heterocyst (structure and function); Morphology, Reproduction, Life-cycle and Symbiotic relationships of *Nostoc* and *Anabaena*. Economic importance of Cyanophyceae.

Unit 3: Chlorophyceae (Green Algae) **(6)**
Occurrence; Cell structure; Morphology, Reproduction and Life-cycle of *Chlamydomonas*, *Volvox*, *Chlorella*, *Ulva*, *Oedogonium*, *Coleochaete*; *Chara*; Structure and Evolutionary significance of *Prochloron*, Economic importance of Chlorophyceae.

Unit 4: Xanthophyceae (Yellow-Green Algae) **(3)**
Occurrence; Morphology, Reproduction, and Life-cycle of *Vaucheria*, Economic importance of Xanthophyceae.

Unit 5: Bacillariophyceae **(3)**
Diatoms and Dinophyceae (Dinoflagellates)
Occurrence, morphology, unique features, Economic importance of Diatoms.

Unit 6: Phaeophyceae (Brown Algae) **(3)**
Occurrence; Morphology, reproduction, and life-cycle of *Ectocarpus,* and *Sargassum*, Economic importance of Phaeophyceae.

Unit 7: Rhodophyceae (Red Algae) **(3)**
Occurrence; Morphology, reproduction, and life-cycle of *Gracilaria*, *Polysiphonia,* Economic importance of Rhodophyceae.

Unit 8: Algal Biotechnology **(8)**
Cultivation of microalgae-*Spirulina* and *Dunaliella*; Algal products- Food and Nutraceuticals, Feed stocks, food colorants; fertilizers, aquaculture feed; therapeutics and cosmetics; medicines; dietary fibres, SCP. Role of algae in climate change, biofuel production and acidification of oceans.

Unit 9: Lichen **(4)**
Occurrence; General characteristics; growth forms and range of thallus organisation; nature of symbiosis, reproduction, role in environment and ecology; Economic importance.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-03

1. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium*, *Chara*, *Vaucheria, Ectocarpus, and Polysiphonia* through temporary preparations, *Fucus, Chlamydomonas, Coleochateae* through preserved specimens and permanent slides and *Prochloron* through electron micrographs.
2. Study of lichen forms- Photographs/preserved specimens

SUGGESTED READINGS/ REFERENCES

1. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae: Structure and Reproduction, 2nd edition. Prentice-Hall International INC.
2. Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Affiliated East-West Press, New Delhi. 3. Lee, R.E. (2018). Phycology, 4th edition: Cambridge University Press, Cambridge.
4. Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer, Dordrecht.
5. Sahoo, D. (2000).Farming the Ocean: Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.

BOTANY (SKILL ENHANCEMENT COURSE)

COURSE CODE: BOT-SEC-T-03(THEORY) & BOT-SEC-P-03(PRACTICAL)

COURSE CREDIT- 3 [2(THEORY) +1 (PRACTICAL)]

FM=45 [25(THEORY) + 10 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE TITLE: A. MUSHROOM CULTURE

COURSE OBJECTIVES:

After completion of the course the learners will be able to:
♣ Describe nutritional and medicinal values of edible mushrooms and their cultivation strategies;
♣ Apply the knowledge gained in storage and food preparation.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-03-A

Unit 1: **(6)**
Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

Unit 2: **(8)**
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.

Unit 3: **(6)**
Storage and nutrition: Short-term storage (Refrigeration – up to 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

Unit 4: **(5)**
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.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-SEC-P-03-A

1. Aseptic inoculation technique.
2. Demonstration of spawning technique, bed preparation.
3. Visit to a mushroom cultivation farm.

[N.B: MARKS DISTRIBUTION OF SEC PRACTICAL PAPER:

PRACTICAL NOTE BOOK-3
FIELD REPORT-4
VIVA VOCE-3]

SUGGESTED READINGS/ REFERENCES:

1. Bahl, N. (1984-1988). Hand book of Mushrooms, II Edition, Vol. I & Vol. II.
2. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
3. Swaminathan, M. (1990). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
4. Tewari, P. and Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
5. Datta B (2023) Mushroom cultivation, 1st edition, Global Net Publication.

COURSE TITLE: B. INTELLECTUAL PROPERTY RIGHTS

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

♣ Identify different types of Intellectual Properties (IPs), right of ownership, scope of protection of IP and ways to create and extract value from IP;
♣ Recognize the role of IP in different sectors for promoting product and technology development;
♣ Identify activities that constitute IP infringements and the remedies available to the IP owner and describe the steps to be taken to prevent infringement of such rights in products and technology development;
♣ Discuss the processes and various approaches of Intellectual Property Management (IPM).

COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-03-B

Unit 1: Introduction to intellectual property rights (IPR) (2)
Concept and kinds. Economic importance. IPR in India and World. Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2: Patents **(2)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3: Copyrights **(2)**

Introduction, works protected under copyright law, rights, transfer of copyright, infringement.

Unit 4: Trademarks **(2)**

Objectives, types, rights, protection of goodwill, infringement, passing off, defences, domain name.

Unit 5: Geographical Indications **(2)**

Objectives, justification, international position, multilateral treaties, national level, Indian position.

Unit 6: Protection of Traditional Knowledge **(5)**

Objective, concept of traditional knowledge, holders, issues concerning, bio-prospecting and bio- piracy, alternative ways, protectability, need for a Sui-Generis regime, traditional knowledge on the International arena, at WTO, at national level, Traditional Knowledge Digital Library.

Unit 7: Industrial Designs **(5)**

Objectives, rights, assignments, infringements, defences of design Infringement. Unit 8: Protection of Plant Varieties, Plant Varieties Protection- objectives, justification, International position, Plant varieties protection in India. Rights of farmers, breeders and researchers. National gene bank, benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 9: Information Technology related Intellectual Property Rights **(2)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection.

Unit 10: Biotechnology and Intellectual Property Rights **(3)**

Patenting Biotech Inventions: objective, applications, concept of novelty, concept of inventive step, microorganisms, moral issues in patenting biotechnological inventions.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-SEC-T-03-B

One seminar lecture has to be delivered on any one of the topics mentioned in the syllabus to aware the public.

[N.B: MARKS DISTRIBUTION OF SEC PRACTICAL PAPER :

PRESENTATION-6
VIVA VOCE-4]

SUGGESTED READINGS/ REFERENCES:

1. Gopalakrishnan, N.S. and T.G. Agitha, (2009). Principles of Intellectual Property. Eastern Book Company, Lucknow.
2. Narayanan, P. (2010). Law of Copyright and Industrial Designs; Eastern law House, Delhi.
3. Parulekar A. and D' Souza, S. (2006). Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. Wadehra, B.L. (2000). Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.

SEMESTER III-MINOR

COURSE CODE: BOT-MI-CC-T-02(THEORY) & BOT-MI-CC-P-02(PRACTICAL)

COURSE TITLE: VASCULAR PLANTS, MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

COURSE CREDIT: 4 [3(THEORY) + 1(PRACTICAL)]

FULL POINTS: 50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Describe general characteristics of pteridophytes, gymnosperms with special reference to their morphology, anatomy and reproduction.
- Describe the morphology and taxonomy of angiosperms.

COURSE CONTENT (TH EORY)
COURSE CODE: BOT-MI-CC-T-02

Unit 1: Pteridophytes **(4)**
General characteristics; Early land plants (*Cooksonia* and *Rhynia*); Systematic position, morphology, anatomy and reproduction of *Lycopodium*, *Selaginella* and *Pteris* (Developmental details not to be included); Heterospory and seed habit; Economical importance.

Unit 2: Gymnosperms **(3)**
General characteristics; Systematic position, morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included); Economic importance.

Unit 3: Morphology of Angiosperms **(5)**
Types of leaves; Phyllotaxy; Types of inflorescence; Morphology of flowers – types of flowers, aestivation, floral formula and floral diagram, adhesion and cohesion of floral parts, placentation types; Types of fruits and seeds.

Unit 4: Introduction to angiosperm taxonomy **(13)**
Identification, Classification, Nomenclature.; Taxonomic hierarchy; Botanical nomenclature-Principles and rules (ICN); binominal system, Typification, Author Citation; Types of classification - artificial, natural and phylogenetic. Outline of Bentham and Hooker (up to series) classification with merits and demerits. Functions of Herbarium, important herbaria and botanical gardens of India.

Salient features, Systematic position (Bentham & Hooker), economically important plants of the following families
Monocotyledon: Poaceae; Orchidaceae
Dicotyledon: Fabaceae (*sensu stricto*); Malvaceae; Solanaceae; Lamiaceae; Asteraceae.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MI-CC-P-02

Unit 1:
Lycopodium- Morphology, Whole Mount of strobilus, (temporary slides), Longitudinal Scetion of strobilus (permanent slide).
Selaginella- morphology, Whole Mount of strobilus, Whole Mount of microsporophyll and megasporophyll (temporary slides), Longitudinal Scetion of strobilus (permanent slide).
Pteris- Morphology, Transverse Section of leaflet.

Unit 2:
Cycas-Megasporophyll (from preserved specimen);
Pinus- Pollen grain (from permanent slide).

Unit 3:
Study of vegetative and floral characters of the following families of the available genera distributed locally according to Bentham and Hooker's system of classification:
Dicotyledon: Fabaceae (*sensu stricto*); Malvaceae; Solanaceae; Lamiaceae; Asteraceae.
Spot identification (Scientific name and Family) of common wild plants from families included in theory syllabus.
Field visits (2 local) and submission of properly preserved herbarium specimens of at least 15 common wild plants with herbarium label, proper field record and field notes. The herbarium specimens should be submitted during end term examination.

SUGGESTED READINGS/REFERENCES:

1. Vashishta P.C., Sinha A.K., Kumar A. (2006). Pteridophyta, S. Chand. Delhi, India.
2. Simpson M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
3. Singh G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
4. Gymnosperms by S. P. Bhatnagar and A. Moitra. New Age international Pvt Ltd., New Delhi, 1996.

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SEMESTER IV –MAJOR

COURSE CODE: BOT-MJ--CC-T-04 (THEORY) & BOT-MJ-CC-P-04 (PRACTICAL)

COURSE TITLE: BRYOPHYTES AND PTERIDOPHYTES

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Will perceive a general idea of Bryophytes and Pteridophytes with special to their classification, morphology, reproduction, distribution and ecology;
- Explain their role in environment, human welfare and in industrial applications;
- Apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-04

Unit 1: Classification of Bryophytes **(2)**
Modern concepts in bryophyte classification with special reference to Shaw and Goffinet (2000).

Unit 2: Type Studies of Bryophyte **(9)**
Range of thallus organisation; Systematic position, morphology, anatomy and reproduction of *Riccia*, *Marchantia*, *Pellia*, *Anthoceros*, *Sphagnum* and *Funaria*.

Unit 3: Origin and Evolution of Bryophytes **(6)**
Origin of bryophytes; Origin of alternation of generation (Homologous and Antithetic theories); Evolution of sporophyte (Progressive and Regressive concepts). Evolutionary trends in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria*.

Unit 4: Basic concepts of Pteridophytes **(3)**
Life cycle patterns of homosporous and heterosporous pteridophytes; Apospory and Apogamy; Habitat diversity.

Unit 5: Classification of Pteridophytes **(2)**
Classification of pteridophytes by Smith *et. al.* (2006) with diagnostic features and example.

Unit 6: Type Studies of Pteridophytes (10)
Systematic position, morphology, anatomy and reproduction of *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Ophioglossum*, *Pteris* and *Marsilea*.

Unit 7: Origin and Evolution (8)
Origin of pteridophytes; Telome concept in land plant evolution; Structural features, Geological and Geographical distributions. Evolutionary trends in early land plants *Cooksonia*, *Rhynia*, *Lepidodendron* and *Calamites*.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ—CC-P-04

Unit 1. *Riccia*
Morphology of thallus. Transverse Section of thallus and sporophyte.

Unit 2. *Marchantia*
Morphology of thallus, Whole Mount of rhizoids and scales, Vertical Section of thallus through Gemma cup (all temporary slides), Longitudinal Section of Antheridiophore, Archegoniophore, and Sporophyte.

Unit 3. *Anthoceros*
Morphology of thallus, Vertical Section of thallus and Longitudinal Section of sporophyte (permanent slide).

Unit 4. *Pellia*
Whole Mount of thallus showing leaf arrangement and sporophyte (permanent slides).

Unit 5. *Sphagnum*
Whole Mount of leaf and Longitudinal Section of sporophyte (permanent slides).

Unit 6. *Funaria*
Morphology, Whole Mount of plant (temporary slides); Longitudinal Section of capsule (permanent slide).

Unit 7. *Psilotum*
Morphology, Transverse Section of synangium (permanent slide).

Unit 8. *Lycopodium*
Morphology, Transverse Section of stem, Whole Mount of sporophyll (temporary slides), Longitudinal Section of strobilus.

Unit 9. *Selaginella*
Morphology, Whole Mount of leaf with ligule, Transverse Section of stem, Whole Mount of microsporophyll and megasporophyll (temporary slides), Longitudinal Section of strobilus.

Unit 10. *Equisetum*
Morphology, Transverse Section of node and internode, Longitudinal Section of strobilus, Transverse Section of strobilus.

Unit 11. *Pteris*
Morphology, Transverse Section of leaflet showing sporangium.

SUGGESTED READINGS/ REFERENCES:

Bryophytes
1. Chopra, R.N. and Kumar, P.K. (1988). Biology of Bryophyta, Wiley Eastern.
2. Parihar, N.S. (1959). Introduction to Embryophyta (Vol. 1 Bryophyta), Central Book Distributors
3. Puri, P. (1980). Bryophyte. Atmaram & Sons.
4. Rashid, A. (1998). An Introduction to Bryophyta, Vikas Publishing House.
5. Ray, S. & Bhattacharya, S. (2016). Manual for Bryophytes: Morphotaxonomy, diversity, spore germination, conservation. Levants Books, Sarat Book Distributors, Kolkata.
6. Schofield, W.B. (2001). Introduction to Bryology, Blackburn Press.
7. Shaw, A. Jonathan and Goffinet Bernard (2009). Bryophyte Biology, Cambridge University Press.
8. Smith, A.J.E. (ed.) (1982). Bryophyte Ecology, Chapman and Hall.
9. Vanderpoorten, A. and Goffinet, B. (2009). Introduction to Bryophytes, Cambridge University Press.
10. Vashista, B.R. (2001). Bryophyta, S. Chand & Company.

Pteridophytes
1. Gifford, E. M. and Foster, A. S. (1998). Morphology & Evolution of Vascular Plants (3rd ed.), Freeman and Co.
2. Mukherjee, R.N. and Chakraborty, K.A. (1995). Introduction to Vascular Cryptogams (Pteridophyta) Kalyani Publications.
3. Parihar, N.S. (1989). The Biology & Morphology of Pteridophytes(2nd ed.), Central Book Distributors.
4. Rashid, A. (1998). An Introduction to Pteridophyta, Latest Ed., Vani Educational Books.
5. Sporne, K.R. (1962). The Morphology of Pteridophyte, Latest Ed., Hutchinson & Co. Ltd. 6. Vashista, P.C. (2006). Pteridophyta. S. Chand & Company Pvt. Ltd

COURSE CODE: BOT-MJ--CC-T-05 (THEORY) & BOT-MJ-CC-P-05 (PRACTICAL)

COURSE TITLE: GYMNOSPERM AND PALAEOBOTANY

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Determine the concept of Progymnosperms and its significance in plant evolutionary history
- Describe general characteristics of Gymnosperms plant group with special reference to their classification, morphology, reproduction, distribution, and ecology;
- Explain their role in environment, and their economic importance;
- Apply this knowledge in understanding their evolutionary significance;
- Describe primordial life forms and their evolution through geological ages;
- Explain the rate of diversification and extinction of plant species;
- Determine the age of sediments and fossils;
- Translate plant fossil evidences to study plant evolution.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-05

Unit 1: Progymnosperms **(2)**
Development of Progymnosperm concept; Diagnostic features of Progymnospermophyta.

Unit 2: Classification of Gymnosperms **(2)**
Classification of gymnosperm by Gifford and Foster (1989) with diagnostic features and examples (from division Pteridospermophyta to Gnetophyta).

Unit 3: Type Studies of Gymnosperms **(8)**
Systematic position, vegetative and reproductive morphology of sporophyte, wood anatomy, development of gametophyte, and embryogeny of *Cycas*, *Pinus*, *Ginkgo*, *Ephedra*, *Gnetum*; Indian distribution of each taxa.

Unit 4: Origin and Evolution of Gymnosperms **(5)**
Origin and evolution of seed habit; Structural features, geological and geographical distribution, evolutionary trends in reconstructed genera *Lyginopteris*, *Williamsonia*, *Cordaites*

Unit 5: Introduction to Palaeobotany **(2)**
Definition of Palaeobotany and Fossil; Uses of fossils.

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Unit 6: Plant fossil & their age determination **(6)**
Rocks containing plant fossils; Environments for fossilization; Modes of preservation (after James M. Schopf, 1975); Perfection of preservation; Geological ages in time scale; Radiometric dating method for age determination of fossil with special reference to radiocarbon dating.

Unit 7: Study of plant fossil records **(4)**
Common form of evidences used in reconstruction of plant fossils with examples; Nomenclature of plant fossils and their problems; Appearance of major plant groups through geological ages as evidenced from plant fossil records.

Unit 8: Evolutionary theories **(5)**
Mass extinction and the plant fossil record Evolutionary theories- Phyletic gradualism and Punctuated equilibrium; Patterns of evolutionary change in the plant fossil records; Definition of mass extinction and five big mass extinction events in Earth's history; Causes of no mass extinction in the plant fossil records.

Unit 9: **Gondwana land and plant fossil (*Glossopteris*)** **(6)**
Concept of Gondwana land and their geological and geographical distributions; Brief idea of *Glossopteris* plant and its importance in establishing existence of Gondwana land; A brief account of three-fold classification of Indian Gondwana system and major mega-fossil assemblages.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-P-05

Gymnosperms

***Cycas*-**Transverse section of leaflet (temporary preparation), morphology of microsporophyll and megasporophyll, L.S. of ovule (permanent slide*).*
Pinus- Transverse section of needle (temporary preparation), longitudinal section of male cone, longitudinal section of female cone (permanent slide), study of pollen from permanent slide.
Gnetum- T.S. of stem, L.S. of ovule (permanent slide).
Ephedra- T.S. of stem, L.S. of ovule (permanent slide).

Palaeobotany

1. Study of external and internal morphology of fossils as representative of major plant groups through geological ages (***Rhynia***- T.S. of stem, ***Lepidodendron***- T.S. of stem, ***Calamites*-** T.S. of stem, ***Glossopteris***-leaf, ***Ptilophyllum*-** leaf, ***Cordaites*-** leaf, ***Lyginopteris*-** T.S. of stem, ***Williamsonia***- fructification, any angiosperm leaf (from available specimens or photographs).
2. Visit to a Fossil Park/Fossil Museum.

SUGGESTED READINGS/REFERENCES:

Gymnosperms

1. Bhatnagar, S.P. and Moitra, A. (1997). Gymnosperm, New Age International.
2. Biswas, C. and Johri, P.M. (1997). The Gymnosperm, Narosa Publishing House.
3. Dutta, S.C. (1984). An Introduction to Gymnosperms (3rd ed.), Kalyani Publishers.
4. Friedman, W.E. (1996). Biology and Evolution of the Gnetales, University of Chicago Press.
5. Gifford, E.M. and Foster, A.S. (1989). Morphology and Evolution of Vascular Plants (3rd ed.), Freeman and Co.
6. Norstag, J. and Nicholls. T.J. (1997). The Biology of the Cycads, Cornell University Press.
7. Sporne, K.R. (1965). The Morphology of Gymnosperms, Hutchinson and Co. Ltd.
8. Vashishta, P.C. (2006). Gymnosperm, S. Chand and Company Pvt.

Palaeobotany

1. Agashe S.N. (1997). Paleobotany: Plants of the Past, Their Evolution, Paleoenvironment and Application in Exploration of Fossil Fuels. Science Publishers, U.S.
2. Andrews, H.N. (1961). Studies in Palaeobotany, John Wiley and Sons.
3. Gifford Ernest M. & Foster Adriance S. (1989). Morphology and Evolution of vascular plants. 3rd edn. New York: Freeman Publ.
4. Meyen, S.V. (1987). Fundamentals of Palaeobotany, Chapman and Hill.
5. Stewart W. N. & Rothwell G. W. (1993). Palaeobotany and the evolution of plants. 2nd edn. Cambridge: Cambridge University Press.
6. Taylor Thomas N., Taylor Edith L. & Krings Michael. (2009). Palaeobotany: The biology and Evolution of fossil plants. 2nd edn. Elsevier Publication.
7. Thomas, B.A. and Spicer, R.A. (1987). The Evolution and Palaeobotany of Land Plants, Croomhelm.
8. Willis K. J. and McElwain J. C. (2002). The evolution of plants. 1st edn. New York: Oxford University Press

SEMESTER V –MAJOR

COURSE CODE: BOT-MJ--CC-T-06 (THEORY) & BOT-MJ-CC-P-06 (PRACTICAL)

COURSE TITLE: PLANT SYSTEMATICS, MORPHOLOGY AND ANATOMY

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- ♣ Describe plants by morphological and anatomical features for correct identification;
- ♣ Explain developmental patterns of both vegetative and reproductive organs of plants;
- ♣ Apply the knowledge gained in taxonomical studies, and evolutionary biology and ontogeny studies;
- ♣ Analyse and comprehend wood structure.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-06

Unit 1: Significance of plant systematics (4)

Introduction to systematics; Plant identification, Classification (Artificial, Natural, Phylogenetic and Modern systems), Nomenclature. Taxonomy and its phases; alpha- and omega-taxonomy. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Documentation: Flora, Virtual herbarium, E-flora, Monographs, Journals; Keys: Single access and Multi-access.

Unit 2: Taxonomic hierarchy (2)

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Unit 3: Botanical nomenclature (3)

Principles and rules (ICN); Ranks and names; Typification, Author Citation, Effective & Valid publication, Rejection of names, Principle of priority and its limitations.

Unit 4: Systems of classification (2)

Outline of classification systems of Bentham and Hooker (1862-1883) (up to series). Outline of Classification System of Angiosperm Phylogeny Group (APG IV), Merits and demerits of both the systems.

Unit 5: Biometrics, numerical taxonomy and cladistics **(2)**
Characters; Variations; OTUs; Cluster analysis; Phenograms, Cladograms (definitions and differences).

Unit 6: Phylogeny of Angiosperms **(2)**
Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly and clades).

Unit 7: Diagnostic features, Systematic position (Bentham and Hooker, and Cronquist), Economically important plants (parts used and uses) of the following families **(10)**
Monocotyledons: Poaceae, Arecaceae, Zingiberaceae, Orchidaceae.
Dicotyledons: Ranunculaceae, Magnoliaceae, Leguminosae (subfamilies), Euphorbiaceae, Malvaceae, Lamiaceae, Solanaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Asteraceae.

Unit 8: Inflorescence **(1)**
Types, Examples.

Unit 9: Morphology of flower **(2)**
Calyx and its modification, types of flowers, aestivation, floral formula and floral diagram, adhesion and cohesion of floral parts, placentation types.

Unit 10: Morphology of fruits **(1)**
Definition and Types of fruits

Unit 11: Tissue **(2)**
Classification of tissues; Simple and complex tissues; Cytodifferentiation of tracheary elements and sieve elements; Pits and Plasmodesmata; Ergastic substances, Hydathodes, Cavities, Lithocytes and Laticifers.

Unit 12: Apical Meristem **(2)**
Organization of shoot apex (Tunica corpus theory, Cytohistological zonations); Organization of root apex (Korper-Kappe theory); Quiscent centre; Root cap.

Unit 13: Primary plant body **(2)**
Primary structure of plant body; Leaf-trace and leaf-gap; Stelar types and evolution.

Unit 14: Secondary plant body **(4)**
Structure and function of Cambium; Secondary growth in root and stem; Anomalous secondary growth (*Bignonia*, *Dracaena*, *Boerhaavia*, and *Tinospora*), Sapwood and Heartwood; Ring and Diffuse porous wood; Early and Late wood, Tyloses, Periderm, Rhytidome and Lenticels.

Unit 15: Epidermal system **(1)**
Trichomes (uni-and multicellular, glandular and nonglandular with examples); Stomatal Types.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-T-06

Plant Systematics

1. Study of vegetative and floral characters of following families of the available genera distributed locally according to Bentham & Hooker's system of classification:
Dicotyledons: Leguminosae (Papilionoidae and Caesalpinioidae); Euphorbiaceae, Malvaceae; Lamiaceae; Solanaceae; Asteraceae
2. Spot identification (Binomial, Family) of common wild plants from families included in Theoretical syllabus.
3. Submission of properly preserved herbarium specimens of at least 15 common wild plants with herbarium label, proper field record and notes. The herbarium specimens should be submitted during End Term Examination and to be arranged following Bentham and Hooker's system of classification.
4. Visit to Acharya Jagadish Chandra Bose Indian Botanic Garden, Shibpur, Howrah and Central National Herbarium.

Morphology & Anatomy

1. Identification with reasons: different types of stipules, inflorescence, flowers and fruits.
2. Identification of apical meristem of root, shoot and vascular cambium (from permanent slides).
3. Identification of types of parenchyma, collenchyma and sclerenchyma (from permanent slide).
4. Work out of the anomalous secondary growth in stems of *Dracaena*, *Boerhaavia*, *Bignonia*, and root of *Tinospora* .
5. Study of leaf anatomy: isobilateral, dorsiventral (from permanent slide).
6. Microscopic identification: xylem (tracheary elements: tracheids, vessel elements, xylem fibres); wood (heart – and sap wood). Phloem (sieve tubes, sieve plates, companion cells, phloem fibres); epidermal system (stomatal types, non- glandular and glandular trichomes); secretory tissues (cavities, lithocytes, laticifers); ergastic substances (cystolith, raphides).

SUGGESTED READINGS/ REFERENCES:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Evert, R.F. (2006). Esau's Plant Anatomy; Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
3. Fahn, A. (1974). Plant Anatomy. Pergamon Press, USA.
4. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/ Cummings Publisher, USA.
5. Sachdeva, S.K. (1990). Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
6. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A
Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd editio

COURSE CODE: BOT-MJ--CC-T-07 (THEORY) & BOT-MJ-CC-P-07 (PRACTICAL)

COURSE TITLE: REPRODUCTIVE BIOLOGY OF PLANTS

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

♣ Explain the process of pollination and fertilization in flowering plants;

♣ Apply the knowledge gained to comprehend self-incompatibility in plants and apply methods to overcome it;

♣ Describe embryo development and seed formation.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ-CC-T-07

Unit 1: Reproductive development (6)

Induction of flowering; Flower as a modified determinate shoot. Flower development: genetic and molecular aspects (ABC model).

Unit 2: Anther and pollen biology (10)

Anther wall: Structure and functions, Microsporogenesis, Callose deposition and its significance. Microgametogenesis; Male germ unit (MGU) structure; Characteristics of pollen grains - polarity, symmetry, shape, size; Abnormal features: Pseudomonads, Polyads, Massulae, Pollinia; NPC system; Pollen wall structure (sporoderm stratification), Pollen wall proteins; Pollen viability, storage and germination.

Unit 3: Ovule (10)

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte – megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and Ultrastructure of mature embryo sac.

Unit 4: Pollination and fertilization (6)

Pollination types and significance; Adaptations; Structure of Stigma and Style; Path of pollen tube in pistil; Double Fertilization.

Unit 5: Self Incompatibility **(10)**

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, Parasexual hybridization; Cybrids, in vitro fertilization.

Unit 6: Embryo, Endosperm and Seed **(10)**

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed : structure, importance and dispersal mechanisms.

Unit 7: Polyembryony and Apomixis **(4)**

Introduction; Classification; Causes and applications.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ-CC-P-07

Work out:

1. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, NPC nomenclature.
2. Pollen viability: Tetrazolium test; Calculation of percentage germination in different media using hanging drop method.

Identification through permanent slides/photographs/electron micrograph

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages, male germ unit (MGU) and schematic representation.
2. Pollen: Psuedomonads, polyads, pollinia, ultrastructure of pollen wall;
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril.
4. Female gametophyte: Types, ultrastructure of mature egg apparatus.
5. Pollination: Intra-ovarian pollination; Test tube pollination.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. Embryogenesis: Study of development of dicot embryo; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

SUGGESTED READINGS/ REFERENCES:

1. Bhattacharya, K., Majumdar, M.R. & Gupta Bhattacharya, S. (2006). A Text Book of Palynology, New Central Book Agency.
2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition. Vikas Publishing House.

3. Erdtman, G. (1986). Pollen Morphology and Plant Taxonomy, Latest Ed., Lelden, E.G. Brill.
4. Faegri, K. and Iversen, J. (1964). Text Book of Pollen Analysis, Munksgor, Copenhagen.
5. Heslop- Harisson (1971). Pollen: Development and Physiology, Butterworth.
6. Johri, B.M. (Ed.). (1982). Experimental Embryology of Vascular Plants, Springer, Heidelberg.
7. Johri, B.M. (Ed.) (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
8. Maheswari, P. (2012). An Introduction to Embryology of Angiosperm, Tata McGraw Hill.
9. Nair, P.K. K. (1970). Pollen Morphology of Angiosperms, Latest Ed., Scholar Publications.
10. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
11. Raghavan, V. (1986). Embryogenesis in Angiosperms: A Development & Experimental Study, 1986, Cambridge University Press.
12. Raghavan, V. (1997). Molecular Embryology of Flowering Plants, Camb. University Press.
13. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
14. Westhaff, P. *et al*. (1998). Molecular Plant Development; From Gene to plant, Oxford University Press.

SEMESTER V- MINOR

COURSE CODE: BOT-MI-CC-T-03(THEORY) & BOT-MI-CC-P-03(PRACTICAL)

COURSE TITLE: CYTOGENETICS, ANATOMY AND EMBRYOLOGY

COURSE CREDIT: 4 [3(THEORY) + 1(PRACTICAL)]

FULL POINTS:50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:
- ♣ Apply plant anatomical features for correct identification;
- ♣ Explain the developmental patterns of both vegetative and reproductive organs of plants;
- ♣ Apply the knowledge gained in taxonomical studies and evolutionary biology and ontogeny studies;
- ♣ Analyse and comprehend wood structure.
- ♣ Apply knowledge about embryological characters in explaining plant reproductive biology.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MI-CC-T-03

CYTOGENETICS:

Unit 1: Cytology **(6)**

Cell as structural and functional unit, Cell Wall, Cell Membrane, Cell Organelles; Chromosome, Nucleosome concept; DNA :Structure (Watson and Crick model), types (A,B,Z); RNA types; Cell Division (mitosis and meiosis).

Unit 2: Mendelian Genetics and its Extension **(4)**

Mendelism, Principles of Inheritance, Chromosomal theory of Inheritance, Laws of Probability, Incomplete Dominance and Co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex linked Inheritance.

Unit 3: Linkage and Crossing Over **(2)**

Linkage and Crossing Over, Cytological basis of Crossing Over, Molecular mechanism of Crossing Over.

Unit 4: Chromosomal Aberrations and Mutations: **(3)**

Deletion, Duplication, Inversion, Translocation; Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations; Physical and chemical mutagens; DNA repair mechanisms.

ANATOMY

Unit 5: Tissues **(5)**
Meristematic tissues and permanent tissues, Root and shoot apical meristems; Simple and Complex tissues; Structure of dicot and monocot root, stem and leaf.

Unit 6: Secondary Growth **(3)**
Vascular Cambium – structure and functions, secondary growth in root and stem; Wood (heartwood and sapwood).

EMBRYOLOGY

Unit 7: Structural Organization of Flower **(2)**
Structure of anther and pollen grains; Structure and type of ovules; Type of embryo sacs, Organization and ultrastructure of mature Embryo Sac.

Unit 8: Pollination and Fertilization **(1)**
Pollination: types; Double fertilization.

Unit 9: Embryo and Endosperm **(2)**
Endosperm : types, structure and functions; Dicot and monocot embryo.

Unit 10: Apomixis and Polyembryony **(2)**
Definition, types and practical applications.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MI-CC-P-03

Cytogenetics
1. Study of different stages of mitosis and meiosis (from permanent slides / photographs).
2. Determination of mitotic index (*Allium cepa*).

Anatomy
3. Study of meristems through permanent slides and photographs.
4. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (permanent slides, photographs).
5. Stem: Monocot (*Zea mays*); Dicot (*Helianthus*) Secondary: *Helianthus* (only permanent slides).
6. Root: Monocot (*Zea mays*/*Colocasia*); Dicot (*Helianthus*); Secondary: *Helianthus* (only permanent slides).
7. Leaf: Dicot and Monocot leaf (only permanent slides)

Embryology
8. Structure of young and mature anther (permanent slides).
9. Types of ovules: anatropous, orthotropous, circinotropous/ amphitropous/ campylotropous (from permanent slides).

10. Female gametophyte: Polygonum (monosporic), type of embryo sac development (permanent slides/photographs).
11. Determination of germination percentage of pollen grains.

SUGGESTED READINGS/ REFERENCES:

1. Klug W.S., Cummings M.R., Spencer C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
2. Snustad D.P. and Simmons M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi, 5th edition.
4. Karp, G. (2010). Cell and Molecular Biology. Concepts and Experiments, 6th Edition. John Wiley and Sons, Inc.
5. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/ Cummings Publisher, USA.
6. Pandey, B.P. (2001). Plant Anatomy. S. Chand and Company Ltd., New Delhi.

SEMESTER VI- MAJOR

COURSE CODE: BOT-MJ--CC-T-08 (THEORY) & BOT-MJ-CC-P-08 (PRACTICAL)

COURSE TITLE: PLANT PHYSIOLOGY AND BIOCHEMISTRY

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- ♣ Discuss plant water relations, i.e. how plants acquire, utilize, and regulate the flow of water between plant and environment;
- ♣ Outline the mineral nutrients plants require, and how they are obtained, metabolized, transported and their role in plants;
- ♣ Explain how plant growth regulators regulate the growth and development in plants;
- ♣ Describe physiology of flowering, light responses and seed dormancy in plants.
- ♣ Understand the structure of carbohydrate, protein, lipid and secondary metabolites and their role in living process.

COURSE CONTENT (THEORY)
COUFSE CODE: BOT-MJ--CC- T-08

Unit 1. Plant water relationship: **(6)**

Chemical structure of water, Importance of water to plants, Soil water types. Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways. Ascent of sap- root pressure, cohesion-tension theory, mechanism of maintaining integrity of water column, cavitation and embolism. Transpiration and factors affecting transpiration, antitranspirants. Mechanism of stomatal movement-effect of blue light, K^+ ion, ABA and CO_2. Guttation.

Unit 2. Translocation in the phloem: **(3)**

Experimental evidence in support of phloem as the site of sugar translocation. Short and long- distance transport, Pressure Flow Model; Phloem loading and unloading; Source sink relationship. P- protein.

Unit 3. Mineral nutrition and Transport: **(5)**
Soil as a nutrient reservoir. Essential and beneficial elements, macro and micronutrients, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.
Transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion. active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport. Culture methods: Hydroponics (Definition and types).

Unit 4. Plant growth regulators: **(5)**
Chemical nature (basic structure), bioassay, physiological roles and mechanism of action of Auxin, Gibberellins and Cytokinin. Physiological roles of Abscisic acid, Ethylene, Brassinosteroids, Jasmonic acid and polyamines.
Synthetic Growth Regulators: Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Unit 5. Physiology of flowering: **(5)**
Photoperiodism and plant types, ABC model of flowering, flowering stimulus, florigen concept, vernalization. Phytochrome- chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action. Role of Cryptochrome and Phototropins in photomorphogenesis. Concept of biological clock and biorhythm.

Unit 6. Plant Movements and Stress Physiology. **(2)**
Tropic and nastic movements. General account on stress physiology. Temperature stress, Cold stress, Salinity stress. Methods adopted by plants to overcome the stress.

Unit 7. Seed dormancy: **(1)**
Types, causes and methods of breaking dormancy.

Unit 8. Carbohydrates: **(2)**
Synthesis of glycosidic bonds – Enzymatic hydrolysis of glycosidic bonds – amylases and invertases.

Unit 9. Amino acids: **(3)**
Classification based on polarity, structure - Amphoteric property of Amino acids, Peptide formation; Amino acid metabolism- reductive amination and transamination.

Unit 10. Proteins: **(2)**
Isoelectric point; Protein denaturation and biological roles of proteins; Role of bonds in stabilizing protein structure - hydrolysis of proteins.

Unit 11. Lipids: **(3)**
Classification – Simple lipids- fats & oils, waxes; Compound lipids- phospholipids, sphingolipids and glycolipids; Derived lipids- Cholesterol and terpenes; Synthesis of ester bonds.

Unit 12. Secondary Plant Products: **(3)**
Introduction – classification and function [General account], Phytochemicals- Alkaloids, terpenoids, phenolics, flavonoids

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ-CC-P-08

1. Determination of osmotic potential of plant cell sap by plasmolytic method using *Rhoeo* leaf.
2. Determination of water potential of potato tissue by weighing method.
3. Study of the effect of wind velocity and light on the rate of transpiration.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the effect of stomatal opening by K^+ ion.
7. To study the effect of temperature on imbibition of seed (Q_{10}).
8. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples.
9. Detection of Ca, Mg, Fe, S from plant ash sample.
10. Preparation of solutions and buffers.
11. Estimation of amino-nitrogen by formol titration method (glycine).
12. Estimation of glucose by Benedicts quantitative reagent.
13. Estimation of titratable acidity from lemon.
14. Estimation of catalase activity in plant samples
15. Colorimetric estimation of protein by Folin phenol reagent.

SUGGESTED READINGS/ REFERENCES:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Jones, R., Ougham, H., Thomas, H., and Waaland, S. (2013). The Molecular Life of Plants. John Wiley and Sons. U.K. 1st edition.
3. Salisbury, F. B. and Ross, C. W. (1992). Plant Physiology. Wordsworth Publishing Company.
4. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
5. Hopkins, W.G. and Huner, A. (2009). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
6. Taiz, L., Zeiger, E., Mller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
7. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007) Biochemistry (Sixth Edition) W.H. Freman & Company, New York.
8. Cox, M.M. and Nelson DL (2017). Lehniger Principle of Biochemistry (Seventh Edition) MacMillan Worth Publishers.
9. Devlin , Thomas M. (2011).Text Book of Biochemistry. John Wiley & Sons, Inc.
10. McKee, Trudy and McKee , James. (2003). Biochemistry. McGraw Hill
11. Hofmann , Andreas and Clokie, Samuel. (2018). Cambridge University Press.
12. Voet, Donald and Voet, Judith G. (2011). Biochemistry. John Wiley & Sons. Inc.
13. Buchanon, Gruissem and Jones ((2000). Biochemistry and Molecular Biology of Plants. I.K. International Pvt. Ltd.
14. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. & Layzel, l D.B. (1997). Plant metabolism (Second Edition) Addison Wesley Longman Ltd., England.
15. Zubay, G.L. (1993). Biochemistry (Third Edition). WmC Brown Publishers.

COURSE CODE: BOT-MJ--CC-T-09 (THEORY) & BOT-MJ-CC-P-09 (PRACTICAL)

COURSE TITLE: PLANT METABOLISM

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

♣ Describe the concepts of different types of metabolisms and their regulation in plants;

♣ Apply the knowledge gained regarding physiological and biochemical details of photosynthesis and respiration, in how they are organized and regulated in plants.

♣ Discuss bioenergetics in regulation of physico-chemical metabolisms in plants and explain the process of signal transduction in plants.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ-CC-T-09

Unit 1: Concept of metabolism: **(4)**

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

Unit 2: Carbon assimilation: **(10)**

Photosynthetic pigments, action and absorption spectrum, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, water splitting mechanism, Q cycle, CO_2 reduction, photorespiration, C4 pathways; Crassulacean acid metabolism (CAM), Facultative CAM, CAM idling and CAM Cycling; Factors affecting CO2 reduction.

Unit 3: Carbon Oxidation: **(10)**

Glycolysis (sucrose as starting material), fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway and its significance, oxidative decarboxylation of pyruvate; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, oxidative phosphorylation, cyanide resistant respiration, inhibitor and uncoupler, factors affecting respiration.

Unit 4: Lipid metabolism: **(6)**

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis, and its role in mobilisation of lipids during seed germination, α oxidation and omega oxidation.

Unit 5: Nitrogen metabolism: **(6)**
Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); genetic interactions between legumes and *Rhizobia* for nodule formation, nitrogenase enzyme- structure and biochemistry of nitrogen fixation; Ammonia assimilation and transamination reactions.

Unit 6: Signal transduction: **(4)**
Mechanisms, receptor-ligand interactions, second messenger concept, Calcium calmodulin, G protein, MAP kinase cascade, phospholipids, cGMP.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ-CC-P-09

1. Separation of photosynthetic pigments by paper chromatography and measure their Rf values.
2. Estimation of total chlorophyll content by Arnon method.
3. To study the effect of light intensity on the rate of photosynthesis.
4. To study the effect of HCO_3 concentrations on the rate of photosynthesis of an aquatic plant and find out the optimum and toxic concentration.
5. Compare the rate of respiration in different parts of a plant.
6. Determine RQ of germinating seeds.
7. Test of seed viability by TTC method.
8. Titrable acidity of *Bryophyllum* leaves/*Aloe vera* leaves.

SUGGESTED READINGS/REFERENCES:

1. Hopkins, W.G. and Huner, A. (2009). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Mller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6th edition.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007) Biochemistry (Sixth Edition) W.H. Freman & Company, New York.
4. Cox, M.M. and Nelson DL (2017) Lehniger Principle of Biochemistry (Seventh Edition) MacMillan Worth Publishers.
5. Thomas, M. Devlin.(2011) Text Book Of Biochemistry. John Wiley & Sons, Inc.
6. Trudy McKee and James McKee (2003).Biochemistry. McGraw Hill
7. Hofmann, Andreas and Clokie, Samuel. (2018). Cambridge University Press.
8. Donald, Voet. and Judith, G Voet.(2011). Biochemistry. John Wiley & Sons. Inc.
9. Buchanon, Gruissem and Jones((2000). Biochemistry and Molecular Biology of Plants. I.K.InternationalPvt.Ltd.
10. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzel, l D.B. (1997) Plant metabolism (Second Edition) Addison Wesley Longman Ltd., England.
11. Zubay, G.L. (1993). Biochemistry (Third Edition). WmC Brown Publishers.

COURSE CODE: BOT-MJ--CC-T-10 (THEORY) & BOT-MJ-CC-P-10 (PRACTICAL)

COURSE TITLE: GENETICS, BIOMETRY AND PLANT BREEDING

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:
- ♣ Explain Mendel's theory of inheritance;
- ♣ Understand the extra chromosomal inheritance;
- ♣ Construct chromosome map;
- ♣ Comprehend the underlying mechanisms of gene mutation;
- ♣ Describe DNA replication and protein synthesis.
- ♣ Get an overview of the hybridization technique;
- ♣ Explain heterosis and hybrid vigour;
- ♣ Understand the role of plant breeding in crop improvement;
- ♣ Analyse statistical data and understand the nature of inheritance.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-10

Unit 1: Mendelian Genetics and Its Extension (5)
Mendelism; Principles of inheritance; Chromosome theory of inheritance; Autosomes and Sex chromosomes; Incomplete Dominance and Codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits.

Unit 2: Extrachromosomal Inheritance (1)
Chloroplast mutation: Variegation in Four o'clock plant (*Mirabilis jalapa*).

Unit 3: Linkage, Crossing Over and Chromosome Mapping (3)
Linkage and Crossing Over-Cytological basis of crossing over; Recombination Frequency, Two factor and Three factor crosses; Three-point mapping; Interference and Coincidence.

Unit 4: Chromosome and Nucleic Acids **(3)**
DNA as genetic material; DNA packaging (Kornberg's Nucleosome Model); DNA replication: Evidence for semi-conservative replication (Meselson and Stahl); Mechanism of Bi-directional replication in bacteria.

Unit 5: Chromosomal Aberration **(3)**
Structural (Deletion, Duplication, Inversion, Translocation) and Numerical (Euploidy and Aneuploidy). Role of Polyploidy in crop improvement.

Unit 6: Fine structure of gene **(1)**
rII Locus.

Unit 7: Gene mutations **(3)**
Types of Mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs; deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. DNA Repair Mechanisms. Role of Mutation Breeding in crop improvement.

Unit 8: Central dogma and genetic code **(2)**
Central Dogma, Genetic code (deciphering and salient features).

Unit 9: Transcription **(3)**
Transcription in prokaryotes; Concept of Operon; Structure and Mode of control of Inducible (lactose operon of *E. coli*) and Repressible (tryptophan operon of *E. coli*) operons. Brief idea about eukaryotic transcription.

Unit 10: Translation **(2)**
Various steps of protein synthesis in prokaryotes.

Unit 11. Population genetics **(1)**
Hardy-Weinberg Law.

Unit 12: Plant Breeding **(1)**
Definition, objectives and importance.

Unit 13: Methods of crop improvement **(5)**
Centre of origin and domestication of crop plants; Plant genetic resources; Acclimatization; Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 14: Quantitative Inheritance **(2)**
Concept, mechanism, examples of inheritance of Kernel colour in wheat, Monogenic vs polygenic inheritance.

Unit 15: Heterosis and Hybrid Vigour **(1)**
Definition and Example.

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Unit 16: Biometry **(4)**

Terms and Definition– sample and population, quantitative and qualitative variables, random sampling, frequency distribution, arithmetic mean, mode and median; Measurement of dispersion –standard deviation, coefficient of variation and standard error; Test of significance – Null Hypothesis, X2 -test of goodness of fit, probability.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ-CC-P-10

1. Meiosis through temporary smear preparation.
2. Determination of goodness of fit in normal (3:1, 1:2:1, 9:3:3:1, 1:1, 1:1:1:1) and modified (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) ratios by Chi-square analysis and comment on the nature of inheritance.
3. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
4. Hybridization technique (Anthesis, Emasculation, Pollination) (Demonstration).
5. Differential pollen stainability following Aceto-armine technique.
6. Analysis of statistical data: Calculation of Mean, Mode, Median, Standard Deviation and Standard Error.

SUGGESTED READINGS/ REFERENCES

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
6. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.
7. Bishop, O.N. (1980). Statistics for Biology, Boston, Houghton, Mifflin.
8. Campbell, R.C. (1998). Statistics for Biologists, Cambridge University Press.
9. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
10. Danniel, W.W. (1987). Biostatistic. New York, John Wiley Sons.
11. Freedman, P. (1950). The Principles of scientific research, New York, Pergamon Press.
12. Selvin, S. (1991). Statistical Analysis of epidemiological data, New York University Press.
13. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
14. Sundar Rao, P.S.S. and Richards, J. (1991). An Introduction to Biostatistics, 3rd edition, Christian Medical College, Vellore.

SEMESTER VII-MAJOR

COURSE CODE: BOT-MJ--CC-T-11 (THEORY) & BOT-MJ-CC-P-11 (PRACTICAL)

COURSE TITLE: MICROBIOLOGY AND IMMUNOLOGY

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Describe general characteristics of viruses, bacteria and algae with special to their morphology, reproduction, distribution and ecology;
- Explain their role in environment, human welfare and in industrial applications;
- Apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-11

Unit 1: Introduction to Microbial World **(3)**

Different groups of microorganisms (virus, archaea, bacteria, fungi, protista, protozoa, mycoplasma, spirochaete, rickettsia, microalgae).

Unit 2: Viruses **(9)**

Discovery, physiochemical and biological characteristics; classification (Baltimore, 1971), general structure with special reference to viroids, virusoids and prions; replication (general accounts). DNA Virus (T4 phage), lytic and lysogenic cycle; RNA virus (TMV); Transmission of plant viruses; brief idea about SARS, MARS, ZIKA, EBOLA virus and Avian flu virus.

Unit 3: Archaea **(2)**

General characteristics, cell structure, types (Methanogens, Halophiles, Thermophiles, Acidophiles, Alkaliphiles, Psychrophiles, Barophiles, Osmophiles).

Unit 4: Bacteria **(9)**

Cell structure, Cell wall, Extra-cellular materials, Flagella and Pili (structure and function); Nutritional types; Bacterial growth; Reproduction - vegetative, asexual and recombination (conjugation, transformation and transduction); Endospore (structure, formation and resistance); Biofilm formation.

Unit 5: Industrial Importance **(4)**
Industrial importance of viruses with special reference to vaccine production and diagnostics;
Industrial importance of bacteria with special emphasis to enzymes (amylase, lipase, protease), Organic acid (citric acid, glutamic acid), alcohol (ethanol) and antibiotic (penicillin, streptomycin). Producing organisms and uses of cheese, vinegar, yoghurt, bread, idli.

Unit 6: Agricultural Importance **(2)**
Biofertilizer and Biopesticide: Definition and uses

Unit 7: Environmental Microbiology **(2)**
Microbes in air, water and soil.

Unit 8: Food Microbiology **(4)**
Food borne pathogen, food spoilage and food preservation

Unit 9: Harmful Activities **(2)**
Plant, animal and human diseases caused by viruses and bacteria

Unit 10: Fundamentals of Immunology. **(3)**
Innate and Acquired immunity, T cell, B cell, MHC, Cytokines, Antigen- types and characteristics, Structure and function of immunoglobulins, cell mediated and Humoral Immunity; Ag-Ab reactions and Immunological techniques.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-11

1. Sterilization technique by Autoclaving, Hot air oven and surface sterilization.
2. Preparation of standard bacteriological medium (nutrient agar, nutrient broth), slant and stabs, pour plate technique, streak plate technique.
3. Sub culturing of bacterial culture.
4. Gram staining.
5. Isolation of lactic acid bacteria from curd.
6. Isolation of Rhizobium from root nodules.

SUGGESTED READINGS/ REFERENCES:

1. Willey, J.M. (2019). Prescott's Microbiology, 11th edition, McGraw Hill.
2. Madigan Michael T. (2017). Brock Biology of Microorganisms. 14th edition. Pearson.
3. Pelczar Chan Krieg. Pelczar Microbiology. 5th edition.
4. Punt Stranford Jones Owen. Kuby Immunology. 8th edition.

COURSE CODE: BOT-MJ-CC-T12 (THEORY) & BOT-MJ-CC-P12 (PRACTICAL)

COURSE TITLE: FUNGI AND PLANT PATHOLOGY

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Differentiate different phyla among the fungi with special reference to their somatic and reproductive features, life cycle pattern
- Understand different applied aspectsof fungi for preparation of food and medicine, role in agriculture, bioremediation and ecological significance as saprotrophs;
- Explain plant pathogen interactions, control spread of plant pathogens and plant diseases

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ-CC-T- 12

Unit 1: Introduction **(4)**

Distinctive features of Fungi to form a Separate Kingdom; Cell wall composition; Structure of *rRNA* gene and its used in fungal phylogeny; Classification (Alexopoulos, Mims and Blackwell, 1996) with salient features of each phyla.

Unit 2: Fungal Spores **(3)**

Fungal spores: types, ultra-structure, dispersal mechanism

Unit 3: Fungal Fruit Body **(2)**

Fruiting structure: Ascocarp: types, development, basidiocarp (parts, external and internal structures) and conidial fructification

Unit 4: Study of Selected Fungal Species **(3)**

Systematic position, Thallus organization, Reproduction, Life cycle of *Synchytrium, Rhizopus, Penicillium (Talaromyces), Ascobolus, Agaricus, Puccinia*

Unit 5: Allied Fungi **(1)**

Fungi allies: Oomycota and Slime molds: Basic difference from true fungi, General characteristics, important plant pathogens.

Unit 6: Fungal Genetics **(2)**

Somatic recombination and Parasexuality

Unit 7: Fungi as Saprotrophs **(1)**
Role of fungi as saprotrophs: Wood decay, White rot fungi and Brown rot fungi

Unit 8: Applied Mycology **(6)**
Applied Mycology: Application of fungi in food industry (Flavour and texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (myco-medicine, antibiotics, anticancer drug); Agriculture (Biofertilizer and Biological control agent); Mycoremediation; *Neurospora* as a model organism

Unit 9: Deleterious Effects of Fungi **(2)**
Harmful effect: Mycotoxin, Human pathogens, Allergens

Unit 10: Introduction to Plant Pathology **(2)**
Plant Pathology: scope; Disease: definition, types; Components of disease development; Epidemiology, General symptoms; Etiology; Koch's postulates

Unit 11: Principles of Plant Pathology **(4)**
Plant-Pathogen interaction: Pathogenesis, role of cell-wall degrading enzymes, toxins, plant growth regulators; Host defense mechanisms: Hypersensitive response, Phytoalexin, Pathogenesis-related protein, Systemic acquired resistance, Induced systemic resistance, Horizontal and vertical resistance

Unit 12: Plant Disease Management **(4)**
Crop protection: Physical, Chemical, Biological methods of plant disease control, Quarantine, IPM

Unit 13: Disease Diagnosis **(1)**
Molecular methods for plant disease diagnosis

Unit 14: Selected Plant Diseases **(5)**
Selected plant diseases: symptoms, etiology, disease cycle and management
Fungal diseases: Black stem rust of wheat, Loose smut of wheat, Brown spot of rice
Oomycete disease: Late blight of potato
Protozoal disease: Club root of crucifers
Bacterial diseases: Citrus canker, Bacterial blight of rice
Viral diseases: Tobacco Mosaic

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ-CC-P-12

1. Study of the following genera through cross section and measurement of reproductive part from temporary mounts and permanent slides: *Rhizopus, Penicillium (Talaromyces), Ascobolus, Agaricus*

2. Identification of all the macroscopic and microscopic genera included in the theoretical syllabus through permanent slides, museum/ herbarium specimens.

3. Identification of following diseases through herbarium specimens:

a) Viral diseases: TMV, Vein clearing.
b) Bacterial diseases; Citrus Canker; Bacterial blight of rice.
c) Oomycete disease: Late blight of potato,
d) Protozoal disease: Club root of crucifers;
e) Fungal diseases: Loose smut of wheat, Black stem rust of wheat, Brown spot of rice.

4. Field note book containing colour photographs of fresh fungal and pathological specimens taken during field works mentioning date and place (GPS tagging) of collection, and for fungal specimens also mention habit (type of fruit-body) and habitat (grow on which substratum) and for pathological specimens also mention name of disease, host and causal agent, should be submitted at the time of term-end examination. Herbarium specimens (at least 10) of diseased plants collected from the locality or at the time of field work to be submitted at the term-end examination.

SUGGESTED READINGS/ REFERENCES:

1. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). IntroductoryMycology, John Wiley & Sons (Asia) Singapore, 4th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
4. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
5. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge, 3rd edition.

COURSE CODE: BOT-MJ-CC-T 13 (THEORY) & BOT-MJ-CC-P 13 (PRACTICAL)

COURSE TITLE: PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

♣ Explain the principles, technical requirement, scientific and commercial applications of plant tissue and cell culture.
♣ Understand different gene transfer techniques.
♣ Explore different methods of recombinant DNA technology for development of transgenic plants.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-13

Unit 1: Recombinant DNA Technology **(8)**

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Unit 2: Gene Cloning **(8)**

Recombinant DNA, Techniques of Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR.

Unit 4: Methods of Gene Transfer **(5)**

Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GFP).

Unit 5: Blotting Techniques **(3)**

Southern, Northern and Western Blots; DNA fingerprinting, basic idea of genomics and proteomics.

Unit 6: DNA Sequencing **(1)**

Manual and automated methods.

Unit 7: Plant Tissue Culture **(8)**

Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications: Micropropagation, Genetic Assessment by Molecular Marker (RAPD and ISSR markers); Androgenesis; Virus elimination; Secondary metabolite production; Haploids; Triploids and Hybrids; Cryopreservation; Germplasm Conservation.

Unit 8: Applications of Biotechnology **(6)**

Pest resistant (Bt-cotton); Herbicide resistant plants (Roundup Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines.

Unit 9: **(1)**

Immobilization of microbial enzymes

.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-13

1. Isolation, purification and estimation of DNA and RNA.
2. Isolation and purification of plant proteins by salting out method.
3. Gel electrophoresis of protein.
4. Plant tissue culture techniques: Media preparation; methods of sterilization.
5. Culture of explants (shoot tips, nodal segments)
6. Callus, cell suspension culture technique.
7. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis and artificial seeds through photographs/videography.
8. Study of methods of gene transfer through photographs/ videography: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
9. Visit to a tissue culture laboratory/ biotechnological park.

SUGGESTED READINGS/ REFERENCES:

1. Bhojwani, S. S. and P. K. Danta (2013). Plant tissue Culture: An Introductory Text, Springer.
2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
3. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier, Science Amsterdam. The Netherlands.
4. Chawla, H.S. (2012). Plant Biotechnology, Oxford IBH.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Ramawat, K.G. (2012). Plant Biotechnology, S. Chand Publication.
7. Singh, B.D. (2012). Plant Biotechnology. Kalyani publisher.
8. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
9. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

SEMESTER VII MINOR

COURSE CODE: BOT-MI-CC-T-04(THEORY) & BOT-MI-CC-P-04(PRACTICAL)

COURSE TITLE: PLANT PHYSIOLOGY & ECOLOGY

COURSE CREDIT: 4 [3(THEORY) + 1(PRACTICAL)]

FULL POINTS:50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Explain plant water relations and elucidate mineral nutrients that plants require, how they are obtained, metabolized and transported;
- Describe physiological details of photosynthesis and respiration in plants;
- Describe enzymes, hormones, environmental responses and nitrogen metabolism required for plant growth and development.

COURSE CONTENT (TH EORY)
COURSE CODE: BOT-MI-CC-T-04

Unit 1: Plant physiology

1. Diffusion, osmosis and imbibition (definition and significance); Movement of water through xylem; Transpiration (mechanisms) and its significance.
2. Concept of Essential elements, macro and micronutrients; Physiological Role of essential elements
3. Pressure flow model; Phloem loading and unloading
4. Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.
5. Aerobic and anaerobic respiration, Glycolysis and TCA cycle.
6. Biological nitrogen fixation.
7. Properties of plant growth regulators and function: auxins, gibberellins, cytokinins.
8. Definition of Photoperiodism, types of plants based on photoperiod.

Unit 2: Plant Ecology

9. Definition, importance and scope of plant ecology.
10. Adaptation of hydrophytes, halophytes and xerophytes.

11. Ecosystem: Structure; energy flow, trophic organization; Food chains and food webs, Ecological pyramids, Biogeochemical cycling; Cycling of carbon, nitrogen and phosphorous.

COURSE CONTENT (PRACTICAL)
CO URSE CODE: BOT-MI-CC-P-04

1. Determination of rate of transpiration (one each from mesophyte and xerophyte) by weighing method.
2. Comparison of rate of imbibition in starchy, proteinaceous and fatty seeds.
3. Effect of bicarbonate concentration on O2 evolution in photosynthesis.
4. Comparison of the rate of respiration in different plant parts.
5. Study of morphological adaptations of hydrophytes and xerophytes (one each).
6. Determination of minimum quadrat number for the study of herbaceous vegetation in the college campus or nearby localities.

SUGGESTED READINGS/REFERENCES:

1. Gangulee H.C., Das K.S., Dutta C. and Kar A.K. (2011). College Botany, Vol. I. New Central Book Agency, Kolkata, India.
2. Mitra, D, Guha, J. Chowdhuri, S.K. (2009). Studies in Botany, Vol. II. Moulik Library, Kolkata, India.
3. Mukherjee S. and Ghosh A.K. (2009). Plant Physiology (2nd Edition), New Central Book agency.
4. Shukla R. S. and Chandel P.S. A text book of plant ecology. S. Chand Publication ,2005.

SEMESTER VIII-MAJOR

COURSE CODE: BOT-MJ--CC-T-14 (THEORY) & BOT-MJ-CC-P-14 (PRACTICAL)

COURSE TITLE: PLANT ECOLOGY, BIODIVERSITY AND CONSERVATION

COURSE CREDIT: 4 [3 (THEORY) + 1 (PRACTICAL)]

FULL POINTS: 50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

♣ Demonstrate an advanced understanding of the application of fundamental principles of ecological studies to the conservation of biodiversity;

♣ Discuss and cite theories and case studies as prerequisites for success in sustainable utilization and effective species conservation;

♣ Translate theoretical aspects of contemporary practices to recommendations for environmental management;

♣ Communicate effectively in the form of written reports and spoken presentations.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-14

Unit 1: Introduction to plant ecology **(1)**

Definition, importance and scope of plant ecology.

Unit 2: Ecological factors **(2)**

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature. Adaptation of hydrophytes, halophytes and xerophytes.

Unit 3: Plant communities **(1)**

Characters; Ecotone and Edge Effect; Succession: Processes and Types.

Unit 4: Ecosystem **(3)**

Structure; Energy flow, Trophic organization; Food chains and Food webs, Ecological pyramids, Production and productivity; Tritrophic interactions (plant defense against herbivore) with reference to Volatile Organic Compounds (VOC) and other secondary compounds, Biogeochemical cycling; Cycling of Carbon, Nitrogen and Phosphorous.

Unit 5: Introduction to Climatology **(1)**
Atmospheric variables, Remote Sensing and Climate Diagrams.

Unit 6: Population Ecology **(4)**
Characteristics of population, Population growth curves, Population regulation, Life history strategies (r and k selection); Metapopulation, Habitat fragmentation, Demes, Source-sink model; Population interactions (competition, parasitism, mutualism).

Unit 7: Phytogeography **(1)**
Botanical zones in India (D. Chatterjee, 1962), Present status; Endemism.

Unit 8: Biodiversity **(3)**
Concept, kinds/levels, importance, methods of study, protection from depletion; Mega-diversity, Hotspot and Hottest spot.

Unit 9: Threats to Biodiversity. **(2)**
Causes of threats; Concept of rare, vulnerable, endangered and threatened plants (IUCN categories).

Unit 10: Conservation **(5)**
Types of conservation: *in-situ* conservation: Biosphere reserve, Wildlife Sanctuaries, National Parks, World Heritage Sites; Concept and Types of Protected Area Networks; *ex-situ* conservation: principles, methods, definition, aims and activities of WWF, Red Data Book, MAB, CITIES, Role of Botanic Gardens and Gene Banks.

Unit 11: Legal aspects of biodiversity and conservation. **(2)**
International Conventions; Important National legal instruments- Acts, Rules and Policies.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-14

1. Study of ecological parameters using the instruments: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/ hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (using pH meter and pH paper).
3. Comparison of physical characteristics (temperature, colour and texture) and water holding capacity of two soil samples.
4. Comparison of chemical characteristics of two soil samples (carbonate content, nitrate content and base deficiency) by rapid field tests.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. Study of morphological adaptations of hydrophytes and xerophytes (two each).
7. Determination of minimum quadrat size for the study of herbaceous vegetation in the college campus or nearby localities, by species area curve method (species to be listed).
8. Determination of minimum quadrat number for the study of herbaceous vegetation in the college campus or nearby localities.
9. Field visit to a different phytogeographical area to familiarize students with ecology of different sites. Submit a field note record.

SUGGESTED READINGS/ REFERENCES:

1. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.

\COURSE CODE: BOT-MJ--CC-T-15 (THEORY) & BOT-MJ-CC-P-15 (PRACTICAL)

COURSE TITLE: ECONOMIC BOTANY AND PHARMACOGNOSY

COURSE CREDIT: 4 [3 (THEORY) + 1 (PRACTICAL)]

FULL POINTS: 50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:
- ♣ Identify the plant parts of economic importance and their uses;
- ♣ Identify the medicinal plants from the pharmacognostic preparations;
- ♣ Distinguish between the adulterants and authentic pharmacognostic preparations;
- ♣ Elucidate the chemical constituents of medicinal plants.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-15

Unit 1: Origin of Cultivated Plants **(2)**
Concept of centre of origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity.

Unit 2: Cereals **(1)**
Rice and Wheat (origin, morphology, processing and uses); Brief account of Millets.

Unit 3: Legumes **(2)**
Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

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Unit 4: Sources of sugars and starches **(2)**

Morphology and processing of Sugarcane, products and by-products of Sugarcane industry. Potato – morphology, propagation and uses.

Unit 5: Spices and Condiments **(3)**

General description of important spices, their families, part used and economic importance with special reference to Coriander, Cumin, Fennel, Saffron, Cardamom, Clove and Black Pepper.

Unit 6: Beverages **(1)**

Tea, Coffee and Cacao (morphology, processing & uses)

Unit 7: Sources of oils and fats **(2)**

General Description, classification, extraction, their uses and health implications Safflower, Linseed, Soybean, Mustard and Coconut (botanical name, family and uses). Essential Oils: General account, extraction methods, comparison with fatty oils and their uses.

Unit 8: Rubber **(1)**

Natural Rubber, Para-rubber: tapping, Processing and Uses.

Unit 10: Timber plants **(1)**

General account with special reference to Teak/ Sissoo and Pine.

Unit 11: Fibers **(1)**

Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Unit 12: Pharmacognosy **(4)**

Introduction , Definition; Drug – Crude and commercial; Preparation of drugs; Organoleptic study of drugs; Physical and chemical evaluation of drugs; Classification of drug plants; Individual drugs; drug adulteration; Constituents.

Unit 13: **(5)**

Study of following drug plants (Botanical name with family, source, short description, histology, constituents, uses, adulterants)

Swertia chirata, Andrographis paniculata, Justicia adhatoda, Aloe barbedensis, Centella asiatica, Ephedra gerardiana, Zingiber officinale, Curcuma longa, Rauvolfia serpentina, Alstonia scholaris, Mentha piperita, Dioscorea alata, Aconitum heterophyllum, Atropa belladonna, Hemidesmus indicus, Withania somnifera.

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COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-15

1. Cereals: Rice/Wheat (Habit sketch, Longitudinal Section /Transverse Section of grain, starch grains, micro-chemical tests).
2. Legumes: Soybean, Gram (Habit sketch, fruit, seed structure, micro-chemical tests).
3. Sources of sugars and starches: Sugarcane (Habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, Transverse Section of tuber to show localization of starch grains, whole mount of starch grains, micro-chemical tests).
4. Spices: Black pepper, Fennel and Clove (habit sketch and sections).
5. Beverages: Tea (Plant specimen/tea leaves), Coffee (Plant specimen/beans).
6. Sources of oils and fats: Coconut- Transverse Section of nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
7. Essential oil-yielding plants: Habit sketch of Rosa, *Vetiveria/ Cymbopogon and Eucalyptus* (specimens/ photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Woods: *Tectona/ Dalbergia, Pinus*: Herbarium and wood specimen, section of young stem.
10. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Pharmacognosy:

Specimens of *Azadirachta* sp*., Adhatoda* sp*., Zingiber* sp., for following examinations-
1. Study of drug plants - Microscopical preparation, Stomatal Index, Vein-islet number, Palisade ratio, Fibres, Vessels.
2. Study of powdered drugs – Morphological observations and identification of tissue elements.

SUGGESTED READINGS/ REFERENCES:

1. Chrispeels, M.J. and Sadava, D.E. (1994). Plants, Genes and Agriculture. Jones & Bartlett.
2. Gangulee, H.C., Kar, A.K. (2011). College Botany, Vol. II. New Central Book Agency (P) Ltd., Kolkata, India.
3. Kochhar, S.L. (2017). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
4. Mitra, D, Guha, J. Chowdhuri, S.K. (2009). Studies in Botany, Vol. II. Moulik Library, Kolkata, India.
5. Ramstad, E. (1959). Modern Pharmacognosy. The Blakiston Division. McGraw-Hill Book Co. New York, USA.
6. Trease, G.E. and Evans, W.C. (1983). Pharmacognosy. Bailliere, Tindall, London, UK.
7. Wickens, G.E. (2001). Economic Botany: Principles and Practices. Kluwer Academic Publishers, The Netherlands.

COURSE CODE: BOT-MJ--CC-T-16 (THEORY) & BOT-MJ-CC-P-16 (PRACTICAL)

COURSE TITLE: ANALYTICAL TECHNIQUES IN PLANT SCIENCE

COURSE CREDIT: 4 [3 (THEORY) + 1 (PRACTICAL)]

FULL POINTS: 50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:
- ♣ Describe various imaging related techniques;
- ♣ Give an overview of the principle of Spectrophotometry and its application in biological research;
- ♣ Characterize proteins and nucleic acids;
- ♣ Analyze statistical data and perform chi-square test for goodness of fit.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-16

Unit 1: Imaging and related techniques **(7)**
Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation **(5)**
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes **(2)**
Use in biological research, auto-radiography, pulse chase experiment.

Unit 4: Spectrophotometry **(1)**
Principle and its application in biological research.

Unit 5: Chromatography **(4)**
Principle; Paper chromatography; Column chromatography, Thin Layer Chromatography (TLC), Gas Liquid Chromatography (GLC), High Performance Liquid Chromatography (HPLC), Ion- exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6: Characterization of proteins and nucleic acids **(4)**

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: Agarose Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE), Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS PAGE)

Unit 7: Bioinformatics **(2)**

DNA and protein sequence analysis through BLAST, Determination of protein molecular weight, iso-electric point and molecular co-efficient, deduction of amino acid from DNA

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-P-16

1. Separation of amino acids by paper chromatography.
2. Buffer preparation.
3. Preparation of Molar, Molal, Normal and Percent solution.
4. Estimation of unknown $CuSO_4$ solution by using standard curve.
5. Pigment separation using solvent method.
6. Estimation of chlorophyll of matured and juvenile leaf by Arnon method.
7. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs and video graphs.

SUGGESTED READINGS/ REFERENCES:

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

COURSE CODE: BOT-MJ--CC-T-17 (THEORY) & BOT-MJ-CC-P-17 (PRACTICAL)

COURSE TITLE: ENTREPRENEURIAL BOTANY

COURSE CREDIT: 6 [2 (THEORY) + 4 (PRACTICAL)]

FULL POINTS: 75 [25 (THEORY) + 50 (PRACTICAL[25] + PROJECT [25])]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Apply his/her knowledge of botany and plant resources to create new business and generate income.

- Identify market opportunities, develop business plan and translate knowledge into practical application.
- Create new product and services.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-17

Unit 1: Marketing management: **(2)**
Brief idea about planning, organising, directing, controlling; goal of marketing management. Cost benefit ratio.

Unit 2: Food adulteration **(4)**
Introduction of food adulteration, types of adulterants in food, food legislation in India, food additives: classification, nature, characteristics and uses of additives in foods (chelating agents, colouring agents, curing agents, emulsions, flavours and flavour enhancers, humectants, nutrient supplements, p^H controlling agents, stabilizers and thickeners); raising agents: types and their role in food processing, artificial colours and artificial flavours.

Unit 3: Production and marketing of mushrooms: (4)
Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms; cultivation technique of oyster mushroom; Storage: Short-term storage (Refrigeration – up to 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions.

Unit 4: Synthetic and herbal abir (gulal/holi powder) **(4)**
Health hazard of chemical gulal: hazardous chemicals, respiratory issues, eye irritation and damage, skin irritation and dermatitis, methemoglobinemia and environmental impact; organic pigments present in different coloured flowers, fruits and vegetables; antioxidant effect of anthocyanin pigments.

Unit 5: Dry flower technique: **(2)**
Definition and importance of dry flower; Methods of flower drying: air drying, embedded drying, freeze drying, water drying, glycerine drying, microwave drying, silica gel drying.

Unit 6: Nursery techniques: **(4)**
Nursery tools and implements; Methods of vegetative propagation (cutting, layering, grafting, budding and bonsai technique); techniques of propagation through specialised organs (corms, bulbs, rhizomes, suckers, bulbil); preparation and application of plant growth regulator solution for seed germination and vegetative propagation; application of fertilizers (biofertilizer, biopesticide, vermicompost) and plant protection chemicals in nursery.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-17

1. Detection of adulterants in different foods (butter; ghee; paneer; edible oil; spices: powder of chilli, turmeric, coriander, cumin; tea; honey; condiments).
2. Cultivation of oyster mushroom; storage of mushrooms (canning, pickles, papads).
3. Herbal gulal/abir preparation.
4. Preparation of dry flower and production of marketable items.
5. Grafting technique, Bonsai technique.
6. Preparation of biofertilizer, biopesticide and vermicompost.
7. **PROJECT**: (Marks distribution: 15 for submission + 5 for presentation + 5 for viva voce)
    - The students undertaking this course shall be allotted a supervisor/ mentor at the beginning of the semester.
    - The student shall select a topic for dissertation from any topic mentioned in **BOT- MJ--CC- T-17** with help from the supervisor/ mentor.
    - The work completed (production to marketing) within the stipulated time and written in standard academic format shall be submitted at the end of the semester.
    - The work shall be evaluated on the basis of the written document submitted by the student and a viva-voce conducted on the same.

SUGGESTED READINGS/ REFERENCES:

1. Singh, Yashpaul. Botany for B.Sc. students- Entrepreneurship in Botany. S. Chand publication.
2. Lokare. Priya Dilip and Pandya. Jay. B. Entrepreneurial Botany. Book Saga Publication.
3. Pathak, Sudhir kumar and Singh Kushwah Janak. Entrepreneurial Botany and Skill development .Nitya Publications
4. Kakare, Priya and Patra, Kamal Kant. Botanical Entrepreneurship. Book Saga Publications
5. Mushroom Farming
6. Dr. Keshamma E. and Lokare, Priya .A Practical Guide for Entrepreneurship. Book Saga Publications.

COURSE CODE: BOT-MJ--CC-T-18 (THEORY) & BOT-MJ-CC-P-18 (PRACTICAL)

COURSE TITLE: STRESS BIOLOGY

COURSE CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:
♣ Describe stress sensing and signaling pathways in plants;

♣ Give an overview of reactive oxygen species (ROS) production and plant's antioxidant defense mechanism;
♣ Comprehend developmental and physiological mechanisms of environmental stress adaptation;
♣ Understand the underlying mechanisms of phytoremediation**.**

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MJ--CC-T-18

Unit 1: Defining plant stress **(5)**
Plant stress, Plant responses to abiotic and biotic stresses- acclimatization and adaptation, Secondary metabolites and plant defense.

Unit 2: Stress factors **(15)**
Drought; Flooding, Salinity, Temperature, Heavy metals stress and potential biotic stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance.

Unit 3: Stress sensing and signaling pathways in plants **(10)**
Role of Ca2+ and mitogen-activated protein kinase (MAPK) in stress sensing and signaling; heat shock proteins (HSPs).

Unit 4: Reactive oxygen species–Production and scavenging mechanisms. **(10)**
Free radicals chemistry, Oxidative stress, Mitochondria as a source for reactive oxygen species, Enzymatic and non-enzymatic antioxidant defense system (Ascorbate-glutathione cycle or Asada-Halliwell pathway), Oxidative damages to lipids, proteins and DNA.

Unit 5: Developmental & physiological mechanisms to confer environmental stresses **(10)**
Adaptation in plants; Changes in root: shoot ratio; Flooding stress and aerenchyma development; Osmotic adjustment; Compatible solute production.

Unit 6: Phytoremediation **(10)**
Bioavailability and accumulation of heavy metals, Naturally occurring plants for Phytoremediation, Brief idea about different mechanisms of Phytoremediation, Transgenic approach of Phytoremediation.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-18

1. Estimation of tissue proline level.
2. Estimation of peroxidase activity in the seedlings grown in the absence and presence of salt stress.
3. Estimation of superoxide dismutase activity in the seedlings grown in the absence and presence of salt stress.
4. Estimation of catalase activity in the seedlings grown in the absence and presence of salt stress.
5. Acquaintance with important phytoremediating plants.

SUGGESTED READINGS/ REFERENCES:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Buchanan, B.B., W. Gruissem, and R.L. Jones (2000). Biochemistry and Molecular Biology of Plants. Wiley-Blackwell-ASPB, Rockville, MD. Sons. U.S.A. 4th edition.

COURSE CODE: BOT-MJ-PRO-1

COURSE TITLE: PROJECT/DISSERTATION

COURSE CREDIT: 12

FULL POINTS: 150

[HONOURS WITH RESEARCH]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- ♣ Apply the knowledge gained through different courses in practical field.
- ♣ Solve problems related to his course of study.
- ♣ Document, calculate, analyse and interpret data.
- ♣ Deduce findings from different studies
- ♣ Write and report in standard academic formats.

COURSE GUIDELINE- BOT-MJ-PRO-1

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- ♣ The students undertaking this course shall be allotted a supervisor/ mentor at the beginning of the semester.
- ♣ The student shall select a topic for dissertation from any field of plant science with help from the supervisor/ mentor.
- ♣ The work completed within the stipulated time and written in standard academic format shall be submitted at the end of the semester.
- ♣ The work shall be evaluated on the basis of the written document submitted by the student and a viva-voce conducted on the same.

[N.B.: MARKS DISTRIBUTION: PRESENTATION-40; SUBMISSION-70; VIVA VOCE-20, SEMINAR PRESENTATION (ANY SCIENTIFIC CONFERENCE)-20.