SYLLABUS

FOR

FOUR YEARS UNDER-GRADUATE COURSE (NEP)

IN

BOTANY

(*w.e.f. 2025-26*)

BANKURA UNIVERSITY

BANKURA

WEST BENGAL

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CONTENTS

1. Introduction

In the present context of NEP-2020 and formulation of a new student-centric "Curriculum and Credit Framework for Undergraduate Programmes (CCFUD)", the syllabus for Botany has been framed following the UGC guidelines facilitating students to pursue their career path by choosing the subject.

Incorporation of flexible choice based credit system, multidisciplinary approach and multiple entry and exit options with a focus on the chosen major and minors as per the choices of the students has properly been made in accordance with our own infrastructure, expertise and strength.

A holistic understanding of the subject giving a substantial weightage to core courses in the major disciplines and broader understanding beyond the major disciplines, is the main objective of framing of this new syllabus.

Adequate emphasis has also been rendered on new techniques and understanding the subject in tune with the changing nature of the subject. Moreover, teaching of basic skills of the subject to the students has not been ignored while framing the syllabus with this spirit that students will get the scope of securing a job & self-employment opportunity after graduation, as everyone might not need to go for higher studies.

Some new topics in the fields of Discipline Specific Core courses, Skill Enhancement course and Multidisciplinary courses have been included in the syllabus for the benefit of students from both theoretical and practical points of view. These are Research Methodology, Industrial and Environmental Microbiology, Bioinformatics, Agronomy, Stress Biology, Natural Resource Management, Analytical techniques in plant sciences, Herbal Technology etc.

1.1. Learning Outcome (LO)

LO	Summary	Description
LO 1	Sound Domain Knowledge	Students can acquire a strong, basic knowledge on origin, evolution and diversification in the basic and applied fields of Botany. They can develop relationship with the environments including their economic values.
LO 2	Laboratory Skill	The syllabus has the aim to develop good laboratory skills with latest advanced tools, sophisticated instruments and modern technologies to address emerging problems with scientific viewpoint.
LO 3	Overall Skill	Students will able to think logically and scientifically in to structural outline, gather appropriate knowledge and skill for future career, planning and conducting independent project proposal and make appropriate report on it.
LO 4	Team Work	The syllabus will enhance the development of the spirit of team work; learn to harbor collaborative approach to explore new facts and facets of the subject.

LO 5	Academic and Scientific Endeavour	Students will gain cognitive development, innovative approach, technical maneuvering, entrepreneurship and managerial skills to set up a new start-up.
LO 6	Eco-friendly Approach	The course has a futuristic approach to develop eco-friendly management practices to make socio-economic upliftment.
LO 7	Ethical Awareness	Development of ethical awareness among students regarding research & publications is another outcome of the proposes course.
LO 8	Goal of life	The syllabus will help to inculcate visions in students so that they can play a vital role for the advancement of the discipline in the greater benefits of the society.

2. Scheme for NEP Curriculum

2.1. Credit Distribution across Courses

Category of Choice (Credit) / SEMESTER	Major (4) DSC	Major (4) DSE	Minor Stream (4)	Multidisci-plinary (3)	Skill Enhancement Courses [SEC] (3)	Ability Enhancement Courses [AEC] (2)	Value Added Courses (Common for all) (4)	Internship (2)	Research Project/ Dissertation (12)	Total Credit/ Number of Courses
I	1×4=4 S/BOT/101/MJC-1		1×4=4 S/BOT/102/MN-1	1×3=3 S/BOT/103/MD-1	1×3=3 S/BOT/104/SEC-1	1×2=2 ACS/105/AEC-1	1×4=4 ACS/106/VAC-1			20/6
II	1×4=4 S/BOT/201/MJC-2		1×4=4 S/BOT/202/MN-2	1×3=3 S/BOT/203/MD-2	1×3=3 S/BOT/204/SEC-2	1×2=2 ACS/205/AEC-2	1×4=4 ACS/206/VAC-2			20/6
CERTIFICATE (Total Credit)	8		8	6	6	4	8	4*(Additional) ACS/207/INT-1		40
III	2×4=8 S/BOT/301/MJC-3 S/BOT/302/MJC-4		1×4=4 S/BOT/303/MN-3	1×3=3 S/BOT/304/MD-3	1×3=3 S/BOT/305/SEC-3	1×2=2 ACS/306/AEC-3				20/6
IV	4×4=16 S/BOT/401/MJC-5 S/BOT/402/MJC-6 S/BOT/403/MJC-7 S/BOT/404/MJC-8		1×4=4 S/BOT/405/MN-4			1×2=2 ACS/406/AEC-4				20/6
DIPLOMA (Total Credit)	32		16	9	9	8	8	4*(Additional) ACS/407/INT-2		82
V	4×4=16 S/BOT/501/MJC-9 S/BOT/502/MJC-10 S/BOT/503/MJC-11 S/BOT/504/MJC-12		1×4=4 S/BOT/505/MN-5					1×2=2 ACS/506/INT-3		22/6
VI	4×4=16 S/BOT/601/MJC-13 S/BOT/602/MJC-14 S/BOT/603/MJC-15 S/BOT/604/MJC-16		1×4=4 S/BOT/605/MN-6							20/5
UG DEGREE (Total Credit)	16×4=64 64		24	9	9	8	8	2		124
VII	4×4=16 S/BOT/701/MJC-17 S/BOT/702/MJC-18 S/BOT/703/MJC-19 S/BOT/704/MJC-20		1×4=4 S/BOT/705/MN-7							20/5
VIII	4×4=16** S/BOT/801/MJC-21 S/BOT/802/MJC-22 S/BOT/803/MJC-23 S/BOT/804/MJC-24		1×4=4 S/BOT/805/MN-8							20/5
UG HONS. (Total Credit)	24×4=96 96		32	9	9	8	8	2		164
UG HONS. WITH RESEARCH (Total Credit)	21×4=84		32	9	9	8	8	2	12** S/BOT/806/RPD-1	

*Additional Summer Internship of 4 credit is mandatory for certificate and diploma courses.

**Honours students not undertaking research will do three courses for 12 credits for Major in lieu of a Research Project/ Dissertation and total four courses in Major in semester-VIII.
Honours with Research students will opt any one core course from available four courses in Major in Semester-VIII

2.2. Scheme for NEP based Curriculum in Botany

SEMESTER- I

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/101/MJC-1	Phycology & Microbiology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/102/MN-1	Phycology & Microbiology (Theory & Practical) (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/103/MD-1	Biofertilizers (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/104/SEC-1	Biofertilizers	3 (T)	10	40	50	3	N.A.	N.A.
ACS/105/AEC-1	Communicative English	2	10	40	50	2	N.A.	N.A.
ACS/106/VAC-1	Environmental Studies	4	10	40	50	4	N.A.	N.A.
Total in Semester - I		**20**	**60**	**240**	**300**			

SEMESTER- II

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/201/MJC-2	Mycology & Phytopathology (Theory & Practical)	4(T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/202/MN-2	Mycology & Phytopathology (Theory & Practical) (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/203/MD-2	Mushroom Culture Technology (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/204/SEC-2	Mushroom Culture Technology	3 (T)	10	40	50	3	N.A.	N.A.
ACS/205/AEC-2	MIL-1 (Santali/Bengali/Sanskrit)	2	10	40	50	2	N.A.	N.A.
ACS/206/VAC-2	Any one of the following: A: Health and Wellness B: Understanding India: Indian Philosophical Traditions and Value Systems C: Basics of Indian Constitution D: Arts and Crafts of Bengal E: Historical Tourism in West Bengal	4	10	40	50	4	N.A.	N.A.
Total in Semester - II		**20**	**60**	**240**	**300**			

SEMESTER- III

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/301/MJC-3	Archegoniate & Palaeobotany (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/302/MJC-4	Biomolecules & Cell Biology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/303/MN-3	Archegoniate &Palaeobotany (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/304/MD-3	Herbal Technology (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/305/SEC-3	Herbal Technology	3 (T)	10	40	50	3	N.A.	N.A.
ACS/306/AEC-3	MIL-2 (Bengali/Sanskrit/Santali)	2	10	40	50	2	N.A.	N.A.
Total in Semester - III		**20**	**60**	**240**	**300**			

SEMESTER- IV

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/401/MJC-5	Morphology & Anatomy of Angiosperms (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/402/MJC-6	Plant Ecology &Phytogeography (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/403/MJC-7	Genetics & Plant Breeding (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/404/MJC-8	Economic Botany & Pharmacognosy (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/405/MN-4	Morphology & Anatomy of Angiosperms (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
ACS/406/AEC-4	Compulsory English: Literature, Language and Communication	2	10	40	50	2	N.A.	N.A.
Total in Semester - IV		**22**	**60**	**240**	**300**			

SEMESTER- V

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/501/MJC-9	Plant Systematics (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/502/MJC-10	Molecular Biology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/503/MJC-11	Reproductive Biology of Angiosperm (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/504/MJC-12	Plant Physiology (Theory &Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/505/MN-5	Plant Systematics (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
ACS/506/INT-3		2	10	40	50			
Total in Semester - V		**22**	**60**	**240**	**300**			

SEMESTER- VI

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/601/MJC-13	Plant Metabolism (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/602/MJC-14	Plant Biotechnology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/603/MJC-15	Industrial & Environmental Microbiology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/604/MJC-16	Natural Resource Management (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/605/MN-6	Plant Physiology & Metabolism (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
Total in Semester - VI		**20**	**50**	**200**	**250**			

SEMESTER- VII

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/701/MJC-17	Agronomy (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/702/MJC-18	Analytical Technique in Plant Science (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/703/MJC-19	Research Methodology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/704/MJC-20	Forestry (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/705/MN-7	Plant Ecology & Phytogeography (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
Total in Semester - VII		**20**	**50**	**200**	**250**			

SEMESTER- VIII

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/801/MJC-21	Horticulture Practice & Post Harvest Technology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/802/MJC-22	Medical Microbiology & Immunology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/803/MJC-23	Bioinformatics (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/804/MJC-24	Stress Biology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/805/MN-8	Cell Biology & Genetics (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
Total in Semester - VIII		**20**	**50**	**200**	**250**			

2.3. Choices for DSC-Major/Minor

SEMESTER	COURSE	CHOICE
SEM–I	MAJOR	MJC-1: Phycology & Microbiology
	MINOR	MN-1: Phycology & Microbiology
SEM-II	MAJOR	MJC-2: Mycology & Phytopathology
	MINOR	MN-2: Mycology & Phytopathology
SEM-III	MAJOR	MJC-3: Archegoniate & Palaeobotany MJC-4: Biomolecules & Cell Biology
	MINOR	MN-3: Archegoniate & Palaeobotany
SEM-IV	MAJOR	MJC-5: Morphology & Anatomy of Angiosperms MJC-6: Plant Ecology & Phytogeography MJC-7: Genetics & Plant Breeding MJC-8: Economic Botany & Pharmacognosy
	MINOR	MN-4: Morphology & Anatomy of Angiosperms
SEM-V	MAJOR	MJC-9: Plant Systematics MJC-10: Molecular Biology MJC-11: Reproductive Biology of Angiosperm MJC-12: Plant Physiology
	MINOR	MN-5: Plant Systematics
SEM-VI	MAJOR	MJC-13: Plant Metabolism MJC-14: Plant Biotechnology MJC-15: Industrial & Environmental Microbiology MJC-16: Natural Resource Management
	MINOR	MN-6: Plant Physiology & Metabolism

2.4. Choices for Multidisciplinary Courses

SEMESTER	COURSE	CHOICE
SEM-I	MD-1	Biofertilizers
SEM-II	MD-2	Mushroom Culture Technology
SEM-III	MD-3	Herbal Technology

2.5. Choices for Skill Enhancement Courses

SEMESTER	COURSE	CHOICE
SEM-I	SEC-1	Biofertilizers
SEM-II	SEC-2	Mushroom Culture Technology
SEM-III	SEC-3	Herbal Technology

2.6. Question Pattern

Major Stream (DSC) and Minor Stream papers

Theory (F.M: 25)	Practical (F.M: 15)
UNIT-I 1. Any five out of eight **1×5= 5**	1. Work out/Demonstration/Experiment and/or Identification: **10/9** 2. Laboratory Record and/or Field record: **2/3** 3. Viva Voce: **3**
UNIT-II 2. Any two out of four **5×2= 10**	
UNIT-III 3. Any one out of two **10×1= 10**	

Multidisciplinary and SEC papers

Theory (F.M: 40)
UNIT-I 1. Any five out of eight **2×5= 10**
UNIT-II 2. Any four out of six **5×4= 20**
UNIT-III 3. Any one out of two **10×1= 10**

SEMESTER - I

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/101/MJC-1	Phycology & Microbiology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/102/MN-1	Phycology & Microbiology (Theory & Practical) (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/103/MD-1	Biofertilizers (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/104/SEC-1	Biofertilizers	3 (T)	10	40	50	3	N.A.	N.A.
ACS/105/AEC-1	Communicative English	2	10	40	50	2	N.A.	N.A.
ACS/106/VAC-1	Environmental Studies	4	10	40	50	4	N.A.	N.A.
Total in Semester - I		**20**	**60**	**240**	**300**			

Major DSC1: Phycology & Microbiology

Course Code: S/BOT/101/MJC-1

Credit: 4

Theory

(Lectures 50/ Marks 25)

Course Learning Outcomes:

- Developing the concept of microbes and algae: classification and types.
- Understanding viruses - their characteristics and structures.
- Understanding the facts regarding diseases and awareness.
- Examining the general characteristics of bacteria and their cell reproduction/Recombination.
- Characteristics of algae and their reproduction.
- Increasing the concept of utilization of viruses bacteria and algae in human welfare.
- Conduct practical experiments using skills appropriate to the study of the microbes and algae.

Phycology (15 Marks)

Unit 1: Algae (10 lectures)
Introduction and general characteristics; Ecology and distribution; Range of thallus organization; cell structure and components; Cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; Methods of reproduction; Classification, criteria, system of Fritsch, and evolutionary classification of Lee, 2008(outline); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar); Role of algae in the environment, agriculture, biotechnology and industry.

Unit 2: Cyanophyta, Xanthophyta and Bacillariophyta (6 lectures)
Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and asexual reproduction of *Nostoc*; Morphology and life-cycle of *Vaucheria*, Cell structure and auxospore formation in Diatoms.

Unit 3: Chlorophyta and Charophyta (6 lectures)
General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas*, *Oedogonium*, *Zygnema*, *Chara*; Evolutionary significance of *Prochloron.*

Unit 4: Phaeophyta and Rhodophyta (8 lectures)
Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia.*

Microbiology (10 marks)

Unit 5: Introduction to Microbial world (5 lectures)

Types of microbes; Economic importance of bacteria and viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of diseases, role in agriculture and industries.

Unit 6: Viruses (5 lectures)

Discovery; Physiochemical and biological characteristics; Classification (Baltimore); General structure with special reference to viroids and prions; Replication (general account); DNA virus(T-phage), lytic and lysogenic cycle; RNA virus (TMV).

Unit 7: Bacteria (10 lectures)

Discovery; general characteristics; Principles and modern approaches of bacterial taxonomy, brief outline classification of domain bacteria, Types - archaebacteria, eubacteria, wall-lessforms (mycoplasma and spheroplasts); Cell structure; Nutrition and nutritional types; Growth and metabolism; Reproduction-vegetative, asexual; Recombination (conjugation, transformation and transduction).

Practical

(Marks 15)

Phycology (08 marks)

Study of vegetative and reproductive structures of *Nostoc*, *Zygnema*, *Oedogonium*, *Chara*. Study of vegetative and reproductive structures of *Fucus and Polysiphonia* (from permanent slides).

Microbiology (07 marks)

1. Electron micrographs/Models of viruses – T2-Phage and TMV, line drawings/ photographs of lytic and lysogenic cycle.
2. Types of bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root nodule.
3. Gram staining and simple staining of bacteria.
4. Endospore staining with malachite green (endospores taken from soil bacteria).
5. Study of microorganisms from curd sample by simple staining process.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4thedition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.

6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
7. Sandikar, B.M. (2021). Fundamental Microbiology, Books & Allied (P) Ltd., Kolkata.
8. Sen, K., Giri, P. (2022). Fundamental Botany: Microbiology, Phycology & Lichenology, Santra publication pvt. Ltd. Kolkata.
9. Mishra, B.K., Dash, N. (2022). Microbiology and Phycology, Kalyani publishers, Delhi.
10. Banerjee, A.K., Banerjee, N. (2008). Fundamentals of Microbiology and Immunology, 2nd edition, New Central Book Agency (P) Ltd., Kolkata.

Minor 1: Phycology & Microbiology

Course Code: S/BOT/102/MN-1

Credit: 4

Theory

(Lectures 50/ Marks 25)

Course Learning Outcomes:

- Developing the concept of microbes and algae: classification and types.
- Understanding viruses - their characteristics and structures.
- Understanding the facts regarding diseases and awareness.
- Examining the general characteristics of bacteria and their cell reproduction/Recombination.
- Characteristics of algae and their reproduction.
- Increasing the concept of utilization of viruses, bacteria and algae in human welfare.
- Conduct practical experiments using skills appropriate to the study of the microbes and algae.

Phycology (15 Marks)

Unit 1: Algae (10 lectures)

Introduction and general characteristics; Ecology and distribution; Range of thallus organization; cell structure and components; Cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; Methods of reproduction; Classification, criteria, system of Fritsch, and evolutionary classification of Lee, 2008(outline); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar); Role of algae in the environment, agriculture, biotechnology and industry.

Unit 2: Cyanophyta, Xanthophyta and Bacillariophyta (6 lectures)

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and asexual reproduction of *Nostoc*; Morphology and life-cycle of *Vaucheria*, Cell structure and auxospore formation in Diatoms.

Unit 3: Chlorophyta and Charophyta (6 lectures)
General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas, Oedogonium, Zygnema, Chara*; Evolutionary significance of *Prochloron.*

Unit 4: Phaeophyta and Rhodophyta (8 lectures)
Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia.*

Microbiology (10 marks)

Unit 5: Introduction to Microbial world (5 lectures)

Types of microbes; Economic importance of bacteria and viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of diseases, role in agriculture and industries.

Unit 6: Viruses (5 lectures)
Discovery; Physiochemical and biological characteristics; Classification (Baltimore); General structure with special reference to viroids and prions; Replication (general account); DNA virus(T-phage), lytic and lysogenic cycle; RNA virus (TMV).

Unit 7: Bacteria (10 lectures)
Discovery; general characteristics; Principles and modern approaches of bacterial taxonomy, brief outline classification of domain bacteria, Types - archaebacteria, eubacteria, wall-lessforms (mycoplasma and spheroplasts); Cell structure; Nutrition and nutritional types; Growth and metabolism; Reproduction-vegetative, asexual; Recombination (conjugation, transformation and transduction).

Practical

(Marks 15)

Phycology (08 marks)

Study of vegetative and reproductive structures of *Nostoc, Zygnema, Oedogonium, Chara.* Study of vegetative and reproductive structures of *Fucus and Polysiphonia*(from permanent slides).

Microbiology (07 marks)

1. Electron micrographs/Models of viruses – T2-Phage and TMV, line drawings/ photographs of lytic and lysogenic cycle.
2. Types of bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root nodule.
3. Gram staining and simple staining of bacteria.
4. Endospore staining with malachite green (endospores taken from soil bacteria).
5. Study of microorganisms from curd sample by simple staining process.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4thedition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
7. Sandikar, B.M. (2021). Fundamental Microbiology, Books & Allied (P) Ltd., Kolkata.
8. Sen, K., Giri, P. (2022). Fundamental Botany: Microbiology, Phycology & Lichenology, Santra publication pvt. Ltd. Kolkata.
9. Mishra, B.K., Dash, N. (2022). Microbiology and Phycology, Kalyani publishers, Delhi.

Multidisciplinary 2: Biofertilizers

Course Code: S/BOT/103/MD-1

Credit: 3

Theory

(Lecture30/Marks 40)

Course Learning Outcomes:

- Know about Biofertilizers which are best defined as biologically active products which help in crop production without any side effects.
- Aware about social justice and wellbeing of rural communities.
- Develop concepts regarding green manuring and organic fertilizers.
- Develop good public health and food security.
- Develop financial security.
- Develop knowledge about vermicomposting and VAM for better crop production.

Unit 1: (4 lectures)
General account about the microbes used as biofertilizer. Rhizobium: isolation, identification, mass multiplication, carrier based inoculants. Actinorrhizal symbiosis.

Unit 2: (8 lectures)
Azospirillum: Isolation and mass multiplication, carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: isolation, identification, mass multiplication, carrier based inoculants.

Unit 3: (4 lectures)
Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, blue green algae (BGA) and *Azolla* in rice cultivation

Unit 4: (8 lectures)
Mycorrhizal association, types of mycorrhizal association, VAM: isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: (6 lectures)
Organic farming: Green manuring and organic fertilizers; Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods; Types and method of vermicomposting, its field Application.

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and Organic Farming, Akta Prakashan, Nadiad.
7. Acaharya, K., Sen, S., Rai, M. (20190 Biofertilizers and Biopesticides, Techno World, Kolkata.

SEC-1: Biofertilizers
Course Code: S/BOT/104/SEC-1
Credit: 3

Theory

(Lecture30/Marks 40)

Course Learning Outcomes:

- Know about Biofertilizers which are best defined as biologically active products which help in crop production without any side effects.
- Aware about social justice and wellbeing of rural communities.
- Develop concepts regarding green manuring and organic fertilizers.
- Develop good public health and food security.
- Develop financial security.
- Develop knowledge about vermicomposting and VAM for better crop production.

Unit 1: (4 lectures)
General account about the microbes used as biofertilizer. Rhizobium: isolation, identification, mass multiplication, carrier based inoculants. Actinorrhizal symbiosis.

Unit 2: (8 lectures)
Azospirillum: Isolation and mass multiplication, carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: isolation, identification, mass multiplication, carrier based inoculants.

Unit 3: (4 lectures)
Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, blue green algae (BGA) and *Azolla* in rice cultivation

Unit 4: (8 lectures)
Mycorrhizal association, types of mycorrhizal association, VAM: isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: (6 lectures)
Organic farming: Green manuring and organic fertilizers; Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods; Types and method of vermicomposting, its field Application.

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and Organic Farming, Akta Prakashan, Nadiad.
7. Acaharya, K., Sen, S., Rai, M. (20190 Biofertilizers and Biopesticides, Techno World, Kolkata.

SEMESTER - II

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/201/MJC-2	Mycology & Phytopathology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/202/MN-2	Mycology & Phytopathology (Theory & Practical) (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/203/MD-2	Mushroom Culture Technology (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/204/SEC-2	Mushroom Culture Technology	3 (T)	10	40	50	3	N.A.	N.A.
ACS/205/AEC-2	MIL-1 (Santali/Bengali/Sanskrit)	2	10	40	50	2	N.A.	N.A.
ACS/206/VAC-2	Any one of the following: A: Health and Wellness B: Understanding India: Indian Philosophical Traditions and Value Systems C: Basics of Indian Constitution D: Arts and Crafts of Bengal E:Historical Tourism in West Bengal	4	10	40	50	4	N.A.	N.A.
Total in Semester - II		**20**	**60**	**240**	**300**			

Major DSC2: Mycology & Phytopathology

Course Code: S/BOT/201/MJC-2

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Developing the knowledge on fungi and basic concept on common plant diseases.
- Practice of skill development in laboratory and field work related to mycology and plant pathology.
- Understanding the knowledge of allied groups of fungi and lichens and the approach of their utilizations in applied fields.

Unit 1: Introduction to fungi (4 lectures)

General characteristics; Thallus organization; Cell wall composition and cell organization; Nutrition; Classification (Ainsworth,1973).

Unit 2: Chytridiomycota and Zygomycota (4 lectures)

Characteristic features; Ecology and significance; Thallus organization; Reproduction; Life cycle with reference to *Synchytrium, Rhizopus.*

Unit 3: Oomycota (4 lectures)

General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.*

Unit 4: Ascomycota (7 lectures)

General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle; Heterokaryosis; Life cycle and classification with reference to *Saccharomyces, Ascobolus.*

Unit 5: Basidiomycota (6 lectures)

General characteristics; Reproduction; Ecology; Life cycle of *Lycoperdon* and *Agaricus*; fairy rings.

Unit6: Deuteromycota (3 lectures)

General accounts, conidial morphology, parasexual cycle; Study of *Alternaria* and *Fusarium.*

Unit 7: Allied Fungi (2 lectures)

General characteristics; Status of slime molds, occurrence, types of plasmodia, types of fruiting bodies.

Unit 8: Symbiotic associations (4 lectures)

Lichen – occurrence, general characteristics, forms and range of thallus organization, Nature of associations of algal and fungal partners, reproduction, importance; Mycorrhiza-ectomycorrhiza, endomycorrhiza and their significance.

Unit 9: Applied Mycology (8 Lectures)

Role of fungi in biotechnology; Application of fungi in food industry (flavour & texture, fermentation, baking, organic acids, enzymes, mycoproteins); Secondary metabolites (pharmaceutical preparations); agriculture (biofertilizers); biological control (mycofungicides, mycoherbicides, mycoinsecticides, myconematicides).

Unit10: Phytopathology (8 lectures)

Terms and concepts; Koch's postulates; general symptoms; geographical distribution of diseases; Etiology; host-pathogen relationships; disease cycle and environmental relation (disease triangle); bacterial diseases – citrus canker and bacterial blight of rice; Viral diseases – tobacco mosaic disease; Fungal diseases – late blight of potato, black stem rust of wheat, brown spot of rice.

Practical

(Marks 15)

Mycology

1. ***Rhizopus*:** study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. ***Albugo*:** Study of symptoms of plants infected with *Albugo*; Asexual phase study through section/temporary mounts and sexual structures through permanent slides.
3. ***Ascobolus*:** Sectioning through ascocarp.
4. ***Puccinia*:** Herbarium specimens of black stem rust of wheat and infected barberry leaves; sections/mounts of spores on wheat and permanent slides of both the hosts.
5. ***Agaricus*:** Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*.

Phytopathology

1. **Phytopathology:** Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: Tobaco Mosaic, Fungal diseases: Late blight of potato, black stem rust of wheat, brown spot of rice and white rust of crucifers.

Suggested Readings

1. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley &Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press,Cambridge. 3rd edition.

4. Deacon, J.W. (2013). Fungal Biology, 4th edition, John Wiley &Sons Ltd.
5. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan PublishersIndia Ltd.
6. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India
7. H. C. L. Gwynne-Vaugham and B. Barnes (2014). Fungi: Their Structure and Development, Biotech Books.
8. Gopinath Hait. 2016. A Text Book of Mycology, New Central Book Agency (P) Ltd.
9. R. S. Mehrotra and A. Aggarwal. 2010. Plant Pathology (Second Edition), Tata Mc Graw Hill Education Pvt. Ltd.

Minor 2: Mycology & Phytopathology
Course Code: S/BOT/202/MN-2
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Developing the knowledge on fungi and basic concept on common plant diseases.
- Practice of skill development in laboratory and field work related to mycology and plant pathology.
- Understanding the knowledge of allied groups of fungi and lichens and the approach of their utilizations in applied fields.

Unit 1: Introduction to fungi (4 lectures)

General characteristics; Thallus organization; Cell wall composition and cell organization; Nutrition; Classification (Ainsworth,1973).

Unit 2: Chytridiomycota and Zygomycota (4 lectures)

Characteristic features; Ecology and significance; Thallus organization; Reproduction; Life cycle with reference to *Synchytrium, Rhizopus.*

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General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.*

Unit 4: Ascomycota (7 lectures)

General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle; Heterokaryosis; Life cycle and classification with reference to *Saccharomyces, Ascobolus.*

Unit 5: Basidiomycota (6 lectures)

General characteristics; Reproduction; Ecology; Life cycle of *Lycoperdon* and *Agaricus*; fairy rings.

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General accounts, conidial morphology, parasexual cycle; Study of *Alternaria* and *Fusarium.*

Unit 7: Allied Fungi (2 lectures)
General characteristics; Status of slime molds, occurrence, types of plasmodia, types of fruiting bodies.

Unit 8: Symbiotic associations (4 lectures)
Lichen – occurrence, general characteristics, forms and range of thallus organization, Nature of associations of algal and fungal partners, reproduction, importance; Mycorrhiza-ectomycorrhiza, endomycorrhiza and their significance.

Unit 9: Applied Mycology (8 Lectures)
Role of fungi in biotechnology; Application of fungi in food industry (flavour & texture, fermentation, baking, organic acids, enzymes, mycoproteins); Secondary metabolites (pharmaceutical preparations); agriculture (biofertilizers); biological control (mycofungicides, mycoherbicides, mycoinsecticides, myconematicides).

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Terms and concepts; Koch's postulates; general symptoms; geographical distribution of diseases; Etiology; host-pathogen relationships; disease cycle and environmental relation (disease triangle); bacterial diseases – citrus canker and bacterial blight of rice; Viral diseases – tobacco mosaic disease; Fungal diseases – late blight of potato, black stem rust of wheat, brown spot of rice.

Practical

(Marks 15)

Mycology

1. ***Rhizopus*:** study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. ***Albugo*:** Study of symptoms of plants infected with *Albugo*; Asexual phase study through section/temporary mounts and sexual structures through permanent slides.
3. ***Ascobolus*:** Sectioning through ascocarp.
4. ***Puccinia*:** Herbarium specimens of black stem rust of wheat and infected barberry leaves; sections/mounts of spores on wheat and permanent slides of both the hosts.
5. ***Agaricus*:** Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*.

Phytopathology

1. **Phytopathology:** Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: Tobaco Mosaic, Fungal diseases: Late blight of potato, black stem rust of wheat, brown spot of rice and white rust of crucifers.

Suggested Readings

3. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley &Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press,Cambridge. 3rd edition.
4. Deacon, J.W. (2013). Fungal Biology, 4th edition, John Wiley &Sons Ltd.
5. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan PublishersIndia Ltd.
6. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India
7. H. C. L. Gwynne-Vaugham and B. Barnes (2014). Fungi: Their Structure and Development, Biotech Books.
8. Gopinath Hait. 2016. A Text Book of Mycology, New Central Book Agency (P) Ltd.
9. R. S. Mehrotra and A. Aggarwal. 2010. Plant Pathology (Second Edition), Tata Mc Graw Hill Education Pvt. Ltd.

Multidisciplinary 2: Mushroom Culture Technology

Course Code: S/BOT/203/MD-2

Credit: 3

Theory

(Lecture 30/ Marks 40)

Course Learning Outcomes

- Idea about various types and categories of mushrooms as edible staff.
- Demonstrate various types of mushroom cultivating technologies.
- Value the economic factors associated with mushroom cultivation.

Unit 1: (5 Lectures)

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: (12 Lectures)

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. Mushroom weeds and pest and its control.

Unit 3: (8 Lectures)
Storage and nutrition: Short-term storage (Refrigeration-up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition-Proteins-amino acids, mineral elements nutrition- Carbohydrates, Crude fibre content-Vitamins.

Unit 4: (5 Lectures)
Food Preparation: Types of foods prepared from mushroom. Research Centres-National level and Regional level. Cost benefit ratio- Marketing in India, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No.88, Mysore Road, Bangalore-560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Handbook of Mushrooms, II Edition, Vol. I & Vol. II.
5. B. C. Suman and V. P. Sharma (2011): Mushroom cultivation and Uses (Agrobios)
6. V. N. Pathak, N. Yadav and M. Gaur. (2011): Mushroom Production and Processing Technology (Agrobios).
7. Reeti Singh and U. C. Singh (2011): Modern Mushroom cultivation (Agrobios).
8. Kapoor, J.N. (2016): Mushroom Cultivation, Indian Council of Agricultural Research, New Delhi.

SEC 2: Mushroom Culture Technology

Course Code: S/BOT/204/SEC-2

Credit: 3

Theory

(Lecture 30/ Marks 40)

Course Learning Outcomes

- Idea about various types and categories of mushrooms as edible staff.
- Demonstrate various types of mushroom cultivating technologies.
- Value the economic factors associated with mushroom cultivation.

Unit 1: (5 Lectures)
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: (12 Lectures)
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. Mushroom weeds and pest and its control.

Unit 3: (8 Lectures)

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

Unit 4: (5 Lectures)

Food Preparation: Types of foods prepared from mushroom. Research Centres-National level and Regional level. Cost benefit ratio- Marketing in India, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No.88, Mysore Road, Bangalore-560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Handbook of Mushrooms, II Edition, Vol. I & Vol. II.
5. B. C. Suman and V. P. Sharma (2011): Mushroom cultivation and Uses (Agrobios)
6. V. N. Pathak, N. Yadav and M. Gaur. (2011): Mushroom Production and Processing Technology (Agrobios).
7. Reeti Singh and U. C. Singh (2011): Modern Mushroom cultivation (Agrobios).
8. Kapoor, J.N. (2016): Mushroom Cultivation, Indian Council of Agricultural Research, New Delhi.

SEMESTER - III

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/301/MJC-3	Archegoniate &Palaeobotany (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/302/MJC-4	Biomolecules & Cell Biology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/303/MN-3	Archegoniate &Palaeobotany (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/304/MD-3	Herbal Technology (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/305/SEC-3	Herbal Technology	3 (T)	10	40	50	3	N.A.	N.A.
ACS/306/AEC-3	MIL-2 (Bengali/Sanskrit/Santali)	2	10	40	50	2	N.A.	N.A.
Total in Semester - III		**20**	**60**	**240**	**300**			

Major DSC 3: Archegoniate & Palaeobotany
Course Code: S/BOT/301/MJC-3
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understanding of archegoniate- Bryophytes, Pteridophytes and Gymnosperms.
- Understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understanding of plant evolution and their transition to land habitat.
- Demonstration of proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms.
- Understanding of plant evolution through time.

Unit 1: Introduction (2 lectures)
Unifying features of archegoniates; Alternation of generations and concept of sporophyte and gametophyte.

Unit 2: Bryophytes (4 lectures)
General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Economic Importance.

Unit 3: Type Studies- Bryophytes (10 lectures)
Classification (Proskauer-1957), morphology, anatomy and reproduction of *Riccia, Marchantia, Anthoceros and Funaria* (developmental stages not included); Evolutionary trends among the genus (developmental stages not included).

Unit 4: Pteridophytes (6 lectures)
General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*; Vegetative and reproductive organography of *Lepidodendron* and *Calamites*).

Unit 5: Type Studies- Pteridophytes (12 lectures)
Classification (Outline of Pichi Sermolli, 1977), Morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory, telome theory, stelar evolution; Ecological and economic importance.

Unit 6: Gymnosperms (12 lectures)
General characteristics, classification- Stewart & Rothwell (1993), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included);

Ecological and economic importance, General account of Progymnospermopsida, *Glossopteris* plant, *Lyginopteris* plant and *Williamsonia* plant.

Unit 7: Palaeobotany (4 Lectures)

Fossils-Definition, Types of Fossils, Importance of fossils, Fossilization Processes, Geological Time-Scale and Megafloral succession.

Practical

(Marks 15)

1. ***Marchantia***- Vertical section of thallus through gemma cup, whole mount of gemmae; Vertical section of antheridiophore, archegoniophore; Longitudinal section of sporophyte.

2. ***Anthoceros***- Vertical section of thallus; T.S. and L.S. of sporophyte.

3. ***Funaria***- Antheridial and archegonial heads from permanent slides; Longitudinal section of capsule.

4. ***Selaginella***- Transverse section of stem; Longitudinal section of strobilus.

5. ***Equisetum***- Morphology, transverse section of internode; Longitudinal section of strobilus, transverse section of strobilus.

6. ***Pteris***- Morphology; Transverse section of rachis; Vertical section of sporophyll; Whole mount of sporangium; Whole mount of spores.

7. ***Cycas***- Whole mount of microsporophyll; Transverse section of rachis; Vertical section of leaflet; Whole mount of spores; Longitudinal section of ovule (from permanent slides).

8. ***Pinus***- Transverse section of Needle; Transverse section of stem; Longitudinal section of/ transverse section of male cone (from permanent slides).

9. **Identification**-Petrified fossil (*Calamites* and *Lyginopteris*), Impression fossil (*Glossopteris*).

10. Botanical excursions are to be organized in botanically rich area, field report and photographic documents of plant specimens to be submitted during practical examination (No need to submit any living, preserved or herbarium specimen).

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.
6. Stewart W.N., Rothwell, G.W. (2005). Paleobotany and the Evolution of Plants, 2nd Edition, Cambridge University Press (USA).
7. Biswas, C., Johri, B.M. (1997). The Gymnosperms. Narosa Publishing House, Delhi.

Major DSC 4: Biomolecules & Cell Biology

Course Code: S/BOT/302/MJC-4

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understanding the basic concept of cell biology.
- This course gives a vast knowledge about cell and its different bio molecules and structure and functions of biomolecules.
- Important information about bioenergetics, enzyme which are really important for the living world.
- A concept about cell organelles, cell cycle, cell division and multiplications.
- Gather knowledge about the biochemical analysis of different biomolecules, Chromosome study, different physical processes involved in cell.

Biomolecules (12 Marks)

Unit 1: Biomolecules (14 lectures)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.
Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.
Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.
Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.
Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

Unit 2: Bioenergenetics (4 lectures)

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 (6 lectures)

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Cell Biology (13 Marks)

Unit 4: The cell (4 lectures)
Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Unit 5: Cell wall and plasma membrane (4 lectures)
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 (14 lectures)
Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.
Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.
Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.
Endomembrane system: Endoplasmic Reticulum – 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; Lysosomes

Unit 7: Cell division (4 lectures)
Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

Practical

(Marks 15)

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 Onion/*Rhoeo*.

3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.

4. Measurement of cell size by the technique of micrometry.

5. Study of the phenomenon of plasmolysis and deplasmolysis.

6. Study of different stages of mitosis (from root tip of *Allium cepa*) and meiosis (from flower buds of *Allium cepa*).

Suggested Readings
1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.

3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman. 4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education, Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
10. Sahu, A.C. (2022) Biomolecules and Cell Biology. Kalyani Publishers, New Delhi.

Minor 3: Archegoniate & Palaeobotany
Course Code: S/BOT/303/MN-3
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understanding of archegoniate- Bryophytes, Pteridophytes and Gymnosperms.
- Understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understanding of plant evolution and their transition to land habitat.
- Demonstration of proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms.
- Understanding of plant evolution through time.

Unit 1: Introduction (2 lectures)
Unifying features of archegoniates; Alternation of generations and concept of sporophyte and gametophyte.

Unit 2: Bryophytes (4 lectures)
General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Economic Importance.

Unit 3: Type Studies- Bryophytes (10 lectures)
Classification (Proskauer-1957), morphology, anatomy and reproduction of *Riccia, Marchantia, Anthoceros and Funaria* (developmental stages not included); Evolutionary trends among the genus (developmental stages not included).

Unit 4: Pteridophytes (6 lectures)
General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*; Vegetative and reproductive organography of *Lepidodendron* and *Calamites*).

Unit 5: Type Studies- Pteridophytes (12 lectures)
Classification (Outline of Pichi Sermolli, 1977), Morphology, anatomy and reproduction of *Selaginella, Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory, telome theory, stelar evolution; Ecological and economic importance.

Unit 6: Gymnosperms (12 lectures)
General characteristics, classification- Stewart & Rothwell (1993), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance, General account of Progymnospermopsida, *Glossopteris* plant, *Lyginopteris* plant and *Williamsonia* plant.

Unit 7: Palaeobotany (4 Lectures)
Fossils-Definition, Types of Fossils, Importance of fossils, Fossilization Processes, Geological Time-Scale and Megafloral succession.

Practical

(Marks 15)

1. ***Marchantia***- Vertical section of thallus through gemma cup, whole mount of gemmae; Vertical section of antheridiophore, archegoniophore; Longitudinal section of sporophyte.

2. ***Anthoceros***- Vertical section of thallus; T.S. and L.S. of sporophyte.

3. ***Funaria***- Antheridial and archegonial heads from permanent slides; Longitudinal section of capsule.

4. ***Selaginella***- Transverse section of stem; Longitudinal section of strobilus.

5. ***Equisetum***- Morphology, transverse section of internode; Longitudinal section of strobilus, transverse section of strobilus.

6. ***Pteris***- Morphology; Transverse section of rachis; Vertical section of sporophyll; Whole mount of sporangium; Whole mount of spores.

7. ***Cycas***- Whole mount of microsporophyll; Transverse section of rachis; Vertical section of leaflet; Whole mount of spores; Longitudinal section of ovule (from permanent slides).

8. ***Pinus***- Transverse section of Needle; Transverse section of stem; Longitudinal section of/ transverse section of male cone (from permanent slides).

9. **Identification**-Petrified fossil (*Calamites* and *Lyginopteris*), Impression fossil (*Glossopteris*).

10. Botanical excursions are to be organized in botanically rich area, field report and photographic documents of plant specimens to be submitted during practical examination (No need to submit any living, preserved or herbarium specimen).

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.
6. Stewart W.N., Rothwell, G.W. (2005). Paleobotany and the Evolution of Plants, 2nd Edition, Cambridge University Press (USA).
7. Biswas, C., Johri, B.M. (1997). The Gymnosperms. Narosa Publishing House, Delhi.

Multidisciplinary 3: Herbal Technology

Course Code: S/BOT/304/MD-3

Credit: 3

Theory

(Theory: Lecture 30/Marks 40)

Course Learning Outcomes:

- Develop knowledge about the medicinal values of different plants.
- Understand about the medicinal plants, its active components, uses.
- Develop knowledge about drug adulteration.
- Understand phytochemical screening tests for secondary metabolites.
- Develop knowledge about micro propagation of important medicinal plant species.

Unit 1: (6 Lectures)
Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2: (6 Lectures)
Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments: Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: (6 Lectures)
Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs: *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster).

Unit 4: (8 Lectures)
Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Unit 5: (4 Lectures)
Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi) Herbal foods-future of pharmacognosy.

Suggested Readings

1. Glossary of Indian medicinal plants, R.N. Chopra, S.L. Nayar and I.C. Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr. C.K. Kokate et al. 1999. Nirali Prakashan.

SEC 3: Herbal Technology

Course Code: S/BOT/305/SEC-3

Credit: 3

Theory

(Theory: Lecture 30/Marks 40)

Course Learning Outcomes:

- Develop knowledge about the medicinal values of different plants.
- Understand about the medicinal plants, its active components, uses.
- Develop knowledge about drug adulteration.
- Understand phytochemical screening tests for secondary metabolites.
- Develop knowledge about micro propagation of important medicinal plant species.

Unit 1: (6 Lectures)
Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2: (6 Lectures)
Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments: Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: (6 Lectures)
Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs: *Catharanthus roseus* (cardiotonic), *Withania somnifera*(drugs acting on nervous system), *Clerodendron phlomoides*(anti-rheumatic) and *Centella asiatica* (memory booster).

Unit 4: (8 Lectures)
Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Unit 5: (4 Lectures)
Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi) Herbal foods-future of pharmacognosy.

Suggested Readings

1. Glossary of Indian medicinal plants, R.N. Chopra, S.L. Nayar and I.C. Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr. C.K. Kokate et al. 1999. Nirali Prakashan.

SEMESTER - IV

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/401/MJC-5	Morphology & Anatomy of Angiosperms (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/402/MJC-6	Plant Ecology & Phytogeography (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/403/MJC-7	Genetics & Plant Breeding (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/404/MJC-8	Economic Botany & Pharmacognosy (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/405/MN-4	Morphology & Anatomy of Angiosperms (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
ACS/406/AEC-4	Compulsory English: Literature, Language and Communication	2	10	40	50	2	N.A.	N.A.
	Total in Semester - IV	**22**	**60**	**240**	**300**			

Major DSC 5: Morphology & Anatomy of Angiosperms
Course Code: S/BOT/401/MJC-5
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Study the external structure of plants for identification of the plant
- Know about different plants organ like root, stem and leaves and their importance.
- Learn about various plants parts, embryonic development, breeding activity and conservation techniques.
- Develop an understanding of concepts and fundamentals of plant anatomy.
- Examine the internal anatomy of plant systems and organs.
- Develop critical understanding on the evolution of concept of organization of shoot
- and root apex.
- Analyze the composition of different parts of plants and their relationships.
- Evaluate the adaptive and protective systems of plants.
- Generating in students an interest in plant structure and wood for having a wise approach in timber use, one of the most economically useful resources.

Morphology (09 Marks)

Unit 1: Root (2 Lectures)
Types and modifications.

Unit 2: Stem (2 Lectures)
Types and modifications.

Unit 3: Leaf (4 Lectures)
Type of leaves; Phyllotaxy; Modifications of leaves, Stipules and their modifications.

Unit 4: Inflorescence and Flower (8 Lectures)
Inflorescence types and evolution; Types of flower; Flower as a modified shoot; Aestivation; Adhesion and cohesion of floral parts; Placentation and its evolution; Floral formula, floral diagram.

Unit 5: Fruits, dispersal of fruits and seeds (5 Lectures)
Definition and types of fruit; Dispersal mechanisms of fruits and seeds.

Anatomy (16 Marks)

Unit 6: Structure and Development of Plant Body (11 Lectures)
Internal organization of plant body; Types of cells and tissues; Tissue systems, Mechanical tissues and its distribution; Pits and plasmodesmata; Ergastic substances; Hydathodes; cavities; lithocysts and laticifers; Cytodifferentiation of tracheary elements and sieve elements.

Unit 7: Apical meristems (8 Lectures)
Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Types of vascular bundles; Structure of dicot and monocot stem; structure of dicot and monocot leaf; Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Root stem transition.

Unit 8: Vascular Cambium and Wood (10 Lectures)
Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses. Development and composition of periderm, rhytidome and lenticels. Anomalous secondary growth in stems (*Bignonia*, *Boerhaavia*, *Strychnos* & *Dracaena*).

Practical

(Marks 15)

Morphology:

1. Identification with reasons: Types of leaves, stipules, tendril, inflorescence, fruits, calyx, corolla, androecium, gynoecium.

2. Dissection and display of: i. Flower of *Canna indica*, ii. Hypanthodium inflorescence of *Ficus glomerata/ Ficus hispida*, iii. Spikelet inflorescence of *Oryza sativa*, iv. Fruits of *Citrus acida*.

Anatomy:

3. T.S. of monocot and dicot root.
4. T.S. of monocot and dicot stem.
5. T.S. of isobilateral and dorsiventral leaves.
6. Anomalous secondary structures of *Bignonia*, *Strychnos*, *Boerhaavia* & *Dracaena* stem

Suggested Readings

Morphology

1. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi.
2. Sachdeva, S. K. 1990. Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
3. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
4. Plant Taxonomy- Nair. Tata Mc. Graw Hill Publisher Company Limited.

Anatomy

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.

2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. 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.
5. Roy, P. (2010) Plant Anatomy. New Central Book Agency (P) Ltd., Kolkata.

Major DSC 6: Plant Ecology & Phytogeography
Course Code: S/BOT/402/MJC-6
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Development of concept on global ecological issues.
- Acquiring knowledge about ecosystems and biodiversity.
- Knowledge about the distribution of plants and their arrangement - both natural and manmade are studied for having a total view to relate the distribution pattern of plants to establish more sustainable plant community systems in the world.
- Understanding core concepts of biotic and abiotic environments.
- Knowledge about soils - physical, chemical and biological components.
- Analysis of the phytogeography or phytogeographical division of India.
- Evaluation of energy sources of ecological system.
- Acquiring the concept of adaptation of plants in relation to light, temperature, water, wind and fire.
- Development of skills for ecological practices.

Unit 1: Introduction (4 lectures)
Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Unit 2: Soil (4 lectures)
Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Unit 3: Water (4 lectures)
Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological cycle; Water in soil; Water table.

Unit 4: Light, temperature, wind and fire (4 lectures)
Variations; adaptations of plants to their variation.

Unit 5: Biotic interactions (4 lectures)
Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

Unit 6: Population ecology (3 lectures)
Characteristics and Dynamics. Ecological Speciation

Unit 7: Plant communities (6 lectures)
Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit 8: Functional aspects of ecosystem (8 lectures)
Structural and functional components of ecosystem. Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Unit 9: Ecological Adaptation (3 Lectures)
Ecological Adaptation of xerophytes, epiphytes and hydrophytes.

Unit 10: Phytogeography (10 lectures)
Principles and objectives of phytogeography; Endemism, theories of endemism, types of endemic species; Brief description of major terrestrial and aquatic biomes; Phytogeographical regions of India.

Practical

(Marks 15)

1. Determination of pH of various soil and water samples (by pH meter and pH paper).

2. Determination of nutrient content of soil by kit-method.

3. Ecological (anatomical) adaptations of some species: *Ipomoea aquatica* stem, Phyllode of *Acaccia auriculiformis*, *Nerium* leaf and *Vanda* root.

4. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus.

7. Field visits to familiarize students with ecosystem of different sites.

Suggested Readings

1. Ambasht, R. S. A Text book of plant ecology. Students Friends Co. Varanasi.
2. Dash, M. C. Fundamentals of Ecology. Tata Mc. Graw Hil Publishing Company Ltd.
3. Good, R. Plant Geography. Oxford & IBH.
4. Kormondy, B. J. 1983. Concept of Ecology (Recent edition) Prentice Hall India Ltd. New Delhi.
5. Kuman, H. D. Modern Concept of ecology. Vikas Publications House New Delhi
6. Odum, E. P. fundamentals of Ecology (recent edition) W. B. Sunders & Co. Philadelphia.
7. Plant Ecology. R. Mishra. Oxford & IBH.
8. Sharma, P. D. Geology and Environment (10^{th} edition). Rastogi Publications. Meerut.
9. Sharma, p. D. Environmental Biology and Toxxicology (10th edition) Rastogi Publications. Meerut. Odum, E. P. Ecology. Hoit Reinhart and Winston Inc.
10. Treatise on Plant Ecology. K. N. Bhatia and k. K. Sharma. (Recent edition) Pradeep Publications Jalaandhar.
11. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

Major DSC 7: Genetics & Plant Breeding
Course Code: S/BOT/403/MJC-7
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Development of detail knowledge about Mendelian and non-Mendelian genetics with several practical approaches.
- Development of concept about the nucleic acids & how nucleic acids transport genetic information among offspring.
- Understanding scientific cause behind several abnormal chromosomal syndromes.
- Understanding basic causes of gene mutation its detection & DNA- repair mechanism.
- Knowledge about the different breeding equipment.
- Understanding the relation between crops and human beings and how much plant breeding is necessary for our growing population.
- Development of knowledge on plant breeding to apply in crop development.
- Interpretation the rules of ICN in botanical nomenclature.
- Assessment of terms and concepts related to phylogenetic systematics.

Genetics (15 Marks)

Unit 1: Mendelian genetics and its extension (10 lectures)
Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Incomplete dominance and codominance; Multiple alleles (ABO blood groups & Rh-alleles), Lethal alleles, Epistasis (Dominant & Recessive), Polygenic inheritance (Kernel colour in wheat & ear size in maize).

Unit 2: Extrachromosomal Inheritance (4 lectures)
Chloroplast inheritance in *Mirabilis jalapa* plant; Mitochondrial inheritance in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

Unit 3: Linkage, crossing over (4 lectures)
Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two Factor and three factor crosses.

Unit 4: Variation in chromosome number and structure (6 lectures)
Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy.

Unit 5: Gene mutations (6 lectures)
Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (UV-ray, X-ray, Base analogs, deaminating, alkylating and intercalating agents); Role of Transposons in mutation, DNA repair mechanisms.

Plant Breeding (10 Marks)

Unit 6: Introduction to Plant Breeding (3 lectures)
Objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit 7: Methods of crop improvement (10 lectures)
Introduction: Centres 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 8: Inbreeding depression and heterosis (3 lectures)
History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 9: Crop improvement and breeding (4 lectures)
Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical

(Marks 15)

1. Testing of goodness of fit with Mendelian monohybrid and dihybrid ratios.

2. Incomplete dominance and gene interaction through seed ratios (9:7, 12:3:1).

3. Study of aneuploidy through photograph: Down's, Klinefelter's and Turner's syndromes.

4. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

5. Hybridization techniques - Emasculation, Bagging (For demonstration only).

6. Induction of polyploidy conditions in plants (For demonstration only).

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Russel, P.J. (2016), iGenetics: A molecular Approach, 3rd edition, Pearson Education (US).
4. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
6. Ajoy, Pal. Text Book of Genetics – from Genes to Genomes, Books and Allied (P) Ltd., Kolkata. 7. Singh, B. D.-Plant Breeding, Kalyani Publishers.
7. Vijendradas L. D.; Plant Breeding. New Age International (p).

Major DSC 8: Economic Botany & Pharmacognosy

Course Code: S/BOT/404/MJC-8

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Learn the relationship between plant and people. This paper intersects many fields such as agronomy, chemistry, anthropology, economy ethnobotany, geography, forestry, horticulture.
- Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems.
- Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership.
- Develop a basic knowledge of taxonomic diversity and important families of useful plants
- Increase the awareness and appreciation of plants & plant products encountered in everyday life.
- Appreciate the diversity of plants and the plant products in human use.
- To know about medicinal properties and uses of plants by folklore and ayurveda system. Ability of conserve rare and threatened plant species both in in-vivo and in-vitro conditions.

Economic Botany (15 marks)

Unit 1: Origin of Cultivated Plants (6 lectures)
Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: Cereals (4 lectures)
Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

Unit 3: Legumes (4 lectures)
Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Unit 4: Sources of sugars and starches (3 lectures)
Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 5: Spices (3 lectures)
Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper.

Unit 6: Beverages (4 lectures)
Tea, Coffee (morphology, processing & uses)

Unit 7: Sources of oils and fats (3 lectures)
Botanical name, family and uses of groundnut, linseed, soybean, mustard and coconut.

Unit 8: Natural Rubber (2 lectures)
Para-rubber: tapping, processing and uses.

Unit 9: Timber plants (2 Lectures)
General account with special reference to teak and pine.

Unit 10: Fibres (4 lectures)
Classification based on the origin of fibres; Cotton, Coir and Jute (morphology, extraction and uses).

Pharmacognosy (10 marks)

Unit 11: General account (10 Lectures)
Definition and history of pharmacognosy, its comparison with pharmacology and pharmacy. Drugs – crude and commercial; preparation of drugs for commercial market; organoleptic, microscopic and physical evaluation of drugs; drug constituents and adulteration.

Unit 12: Drug-yielding plants: (5 Lectures)
Organoleptic properties, microscopic features, active constituents and therapeutic uses of *Cinchona* spp., *Rauwolfia serpentina, Strychnosnux-vomica, Justicia adhatoda.*

Practical

(Marks 15)

Economic Botany:

1. **Cereal**: Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).

2. **Legume**: Groundnut, (habit sketch, fruit, seed structure, micro-chemical tests).

3. **Source of sugar**: Sugarcane (habit sketch; cane juice- micro-chemical tests).

4. **Source of oil**: Mustard–plant specimen, tests for oil in crushed seeds.

5. **Fibre-yielding plant**: Cotton (specimen, whole mount of seed to show lint and fuzz; whole Mount of fiber and test for cellulose).

Pharmacognosy:

6. **Drug-yielding plants**: Organoleptic and microscopic studies of *Strychnos nux-vomica* seed, *Justicia adhatoda* leaf, *Zingiber officinale* rhizome.

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.
4. Bhattacharya, K., Ghosh, A.K., Hait, G. (2017). A Textbook of Botany, Vol-IV, New Central Book Agency (P) Ltd.
5. Mahammad Ali. (2010). Text Book of Pharmacognosy. CBS publishers. 6. Tayler, V. E. 1988. Pharmacognosy.

Minor 4: Morphology & Anatomy of Angiosperms
Course Code: S/BOT/405/MN-4
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Study the external structure of plants for identification of the plant
- Know about different plants organ like root, stem and leaves and their importance.
- Learn about various plants parts, embryonic development, breeding activity and conservation techniques.
- Develop an understanding of concepts and fundamentals of plant anatomy.
- Examine the internal anatomy of plant systems and organs.
- Develop critical understanding on the evolution of concept of organization of shoot
- and root apex.
- Analyze the composition of different parts of plants and their relationships.
- Evaluate the adaptive and protective systems of plants.
- Generating in students an interest in plant structure and wood for having a wise approach in timber use, one of the most economically useful resources.

Morphology (09 Marks)

Unit 1: Root (2 Lectures)
Types and modifications.

Unit 2: Stem (2 Lectures) Types and modifications.

Unit 3: Leaf (4 Lectures)
Type of leaves; Phyllotaxy; Modifications of leaves, Stipules and their modifications.

Unit 4: Inflorescence and Flower (**8 Lectures**)
Inflorescence types and evolution; Types of flowers; Flower as a modified shoot; Aestivation; Adhesion and cohesion of floral parts; Placentation and its evolution; Floral formula, floral diagram.

Unit 5: Fruits, dispersal of fruits and seeds (5 Lectures)
Definition and types of fruit; Dispersal mechanisms of fruits and seeds.

Anatomy (16 Marks)

Unit 6: Structure and Development of Plant Body (11 Lectures)
Internal organization of plant body; Types of cells and tissues; Tissue systems, Mechanical tissues and its distribution; Pits and plasmodesmata; Ergastic substances; Hydathodes; cavities; lithocysts and laticifers; Cytodifferentiation of tracheary elements and sieve elements.

Unit 7: Apical meristems (8 Lectures)
Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Types of vascular bundles; Structure of dicot and monocot stem; structure of dicot and monocot leaf, Kranz anatomy; Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Root stem transition.

Unit 8: Vascular Cambium and Wood (10 Lectures)
Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses. Development and composition of periderm, rhytidome and lenticels. Anomalous secondary growth in stems (*Bignonia*, *Boerhaavia*, *Strychnos* & *Dracaena*).

Practical

(Marks 15)

Morphology:

1. Identification with reasons: Types of leaves, stipules, tendril, inflorescence, fruits, calyx, corolla, androecium, gynoecium.

2. Dissection and display of: i. Flower of *Canna indica*, ii. Hypanthodium inflorescence of *Ficus glomerata/ Ficus hispida*, iii. Spikelet inflorescence of *Oryza sativa*, iv. Fruits of *Citrus acida*.

Anatomy:

3. T.S. of monocot and dicot root

4. T.S. of monocot and dicot stem.

5. T.S. of isobilateral and dorsiventral leaves.

6. Anomalous secondary structures of *Bignonia*, *Strychnos*, *Boerhaavia* & *Dracaena* stem

Suggested Readings

Morphology

1. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi.
2. Sachdeva, S. K. 1990. Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
3. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
4. Plant Taxonomy- Nair. Tata Mc. Graw Hill Publisher Company Limited.

Anatomy

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. 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.
5. Roy, P. (2010) Plant Anatomy. New Central Book Agency (P) Ltd., Kolkata.

SEMESTER - V

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/501/MJC-9	Plant Systematics (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/502/MJC-10	Molecular Biology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/503/MJC-11	Reproductive Biology of Angiosperm (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/504/MJC-12	Plant Physiology (Theory &Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT//505/MN-5	Plant Systematics (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
ACS/506/INT-3		2	10	40	50			
Total in Semester - V		**22**	**60**	**240**	**300**			

Major DSC 9: Plant Systematics

Course Code: S/BOT/501/MJC-9

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Knowledge about appropriate method of identification of plants to contribute classification to trace the evolution and interpretation among the plants.
- Understanding the principles of general taxonomy and nomenclatural rules.
- Explanation of concept of species.
- Development of the concept to classify plants
- Recognition of the importance of herbarium, virtual herbarium and botanic garden.
- Interpretation the rules of ICN in botanical nomenclature.
- Assessment of terms and concepts related to phylogenetic systematics.

Unit 1: Significance of Plant Systematics (6 lectures)
Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry. Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Phases of taxonomy.

Unit 2: Taxonomic hierarchy (4 lectures)
Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Unit 3: Botanical nomenclature (6 lectures)
Principles and rules (ICN); Ranks and names; Typification, author citation, effective and valid publication, rejection of names, principle of priority and its limitations.

Unit 4: Systems of classification (8 lectures)
Types of angiospermic plant classification, Broad outline, relative merits and demerits of major systems of classifications – Bentham and Hooker, and Cronquist (1988). Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit 5: Biometrics, numerical taxonomy and cladistics (8 lectures)
Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit 6: Phylogeny of Angiosperms (8 lectures)
Terms and concepts (primitive and advanced taxa, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms.

Unit 7: **Salient features of the following families (10 lectures)**

[Evolutionary trends need to be briefly discussed in case of families marked with asterisks]

Dicotyledons: Magnoliaceae*, Malvaceae, Brassicaceae, Fabaceae, Euphorbiaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Asteraceae*.

Monocotyledons: Alismataceae*, Poaceae, Musaceae, Orchidaceae*.

Practical

(Marks 15)

1. Study of vegetative and floral characters of the following families (Description, V.S. flower,Section of ovary, floral diagrams, floral formula/e and identification upto the genus following any published keys.

Families: Malvaceae, Fabaceae, Apocynaceae, Asclepiadaceae, Asteraceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Euphorbiaceae.

2. **Field visits** (local and at least one distal)- Excursion/Field trips are to be organized in botanically rich areas. A field report with photographic document of plants (at least 20) and corresponding field record to be submitted during practical examination.

3. Submission of a properly dried and pressed herbarium specimen of any one wild plant.

Suggested Readings

1. College Botany Vol. III. New Central Book Agency. Calcutta.
2. Sharma, O.P. 2009. Plant Taxonomy. Mc Graw Hill Education Pvt. Ltd., India.
3. Pandey, H.P. 2010. Principles of Plant Systematics: With special reference to Current Trends in Plant Taxonomy, Lambert Academic Publishing.
4. Pandey, A.K., Khasana, S. 2021. Plant Systematics, 1st edition, CRC Press.
5. Simpson, M.G. 2019. Plant Systematics, 3rd edition, Elsevier.
6. Datta, S. C. 1991. Systematic Botany. Wiley Eastern Ltd. New Delhi, Calcutta.
7. Judd, Campbell, Kellogg. Stevens. 2003. Phylogeny & Evolution of Vascular Plants. Sinaurer Associates Inc. Publishers Sunderland. Massachusetts. USA.
8. Lawrence, G. H. M. 1981. Taxonomy of Vascular Plants. Mc Milian New York.
9. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi
10. Plant Groups. (Recent Edition). H. Mukherjee. New Central Book Agency.
11. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
12. Plant Systematics. Simpson. 2006. Elsivier. 11. S. K. Mukherjee. 1984.
13. Sachdeva, S. K. 1990. Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
14. Sporne, K. R. 1974. The Morphology of Angiosperms: The structure and evolution of flowering plants. Hutchinson University Library. London.
15. Takhtajan, A. 2009. Flowering Plants, Springer.
16. Takhtajan, A. 1986. Diversity & Plant Distribution. Oliver & Boyd.

17. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
18. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.
19. Bhttacharya, K. Majumder, M.R. and Gupta Bhattacharya, S (2023). A Text Book of Palynology. New Central Book Agency (P) Ltd., Kolkata.

Major DSC 10: Molecular Biology
Course Code: S/BOT/502/MJC-10
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcome:

- Studies of the structures and chemical properties of DNA and RNA to develop practical concept.
- Study of replication of DNA and Transcription of RNA will be studied to prepare the concept of central dogma – an essential lively process to control life.
- Acquiring the molecular concept of protein synthesis and related cellular reactions and the basic knowledge of instrumentation to study these reactions will be acquired.

Unit 1: Nucleic acids: Carriers of genetic information (4 lectures)
Historical perspective; Nucleic Acids as the carrier of genetic information (DNA -Griffith's, Hershey & Chase; RNA-Fraenkel-Conrat's experiment).

Unit 2: The Structures of DNA and RNA (8 lectures)
DNA Structure: Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; RNA Structure, Organelle DNA- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure, Euchromatin, Heterochromatin-Constitutive and Facultative heterochromatin.

Unit 3: The replication of DNA (8 lectures)
General principles–bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication: Rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, Enzymes involved in DNA replication.

Unit 4: Transcription (14 lectures)
Transcription in prokaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli.*; Gene silencing.

Unit 5: Translation (10 lectures)
The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features). Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis: Initiation, elongation and termination of polypeptides in prokaryotes; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Unit 6: Processing and modification of RNA (6 lectures)
Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing; eukaryotic mRNA processing (5′ cap, 3′ poly A tail); Ribozymes.

Practical

(Marks 15)

1. Preparation of LB medium and raising *E. coli.*
2. Demonstration of isolation of genomic DNA from *E. coli.*
3. DNA estimation by diphenyl amine reagent/ UV Spectrophotometry.
4. Study of DNA replication mechanisms through photographs (Rolling circle, theta replication and semi-discontinuous replication).
5. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
6. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
7. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, NewYork, U.S.A.6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th 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. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W.H. Freeman and Co., U.S.A.10th edition.
6. Paul, A., Text Book of Cell and Molecular Biology, Books and Allied (P) Ltd., Kolkata.

Major DSC 11: Reproductive Biology of Angiosperms

Course Code: S/BOT/503/MJC-11

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- The students will be able to understand different reproductive parts of angiosperm and their functions. They also study about different kind of pollen grain, their structure and functions and also their effects on animals.
- Palynology involved in plant identification.
- Important to learn about various plants parts, embryonic development, breeding activity and conservation techniques.
- Recall the history of reproductive biology of angiosperms & recognize the importance of genetic and molecular aspects of flower development
- Understand structure and functions of different reproductive structures.
- Solve Self-incompatibility in Pollination and fertilization.

Unit 1: Introduction and History of palynology (2 lectures)

Unit 2: Reproductive development (4 lectures)

Induction of flowering; Flower development: Genetic and molecular aspects.

Unit 3: Anther and pollen biology (10 lectures)

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, Pollen aperture and ornamentation, NPC system; Palynology and scope (a brief account); Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 4: Ovule (8 lectures)

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

Unit 5: Pollination and fertilization (6 lectures)

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Unit 6: Self incompatibility (8 lectures)

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 7: Embryo, Endosperm and Seed (10 lectures)
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

Units 8: Polyembryony and apomixis (2 lectures)
Introduction; Classification; Causes and applications.

Practical

(Marks 15)

1. **Anther**: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.

2. **Pollen grains**: Abnormal features of pollen grains: psuedomonads, polyads, pollinia (slides/ photographs, fresh material); Ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test; Pollen germination: Calculation of percentage germination in different media using hanging drop method.

3. **Ovule:** Types-anatropous, orthotropous, amphitropous, campylotropous, circinotropous, unitegmic, bitegmic; Tenui nucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/ specimens/ photographs).

4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.

5. Intra-ovarian pollination; Testtube pollination through photographs.

6. **Endosperm:** Dissections of developing seeds for endosperm with free-nuclear haustoria.

7. **Embryogenesis:** Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M.l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Mishra, B.K., Dash, N. (2022). Reproductive Biology of Angiosperms. Kalyani Publishers, New Delhi.

Major DSC 12: Plant Physiology

Course Code: S/BOT/504/MJC-12

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understand Water relation of plants with respect to various physiological processes.
- Explain chemical properties and deficiency symptoms of minerals in plants
- Explain the significance of nitrogen fixation
- Students acquire the adequate knowledge of translocation in plants.
- Explain the ATP-Synthesis
- Acquire adequate knowledge about plant growth regulators, phytochrome and flowering of plants.

Unit 1: Plant-water relations (8 lectures)
Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

Unit 2: Mineral nutrition (6 lectures)
Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

Unit 3: Nutrient Uptake (6 lectures)
Soil as a nutrient reservoir, 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.

Unit 4: Translocation in the phloem (6 lectures)
Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit 5: Plant growth regulators (12 lectures)
Chemical nature (basic structure), Concept of natural and synthetic hormones, bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid & Ethylene.

Unit 6: Physiology of flowering (6 lectures)
Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Unit 7: Phytochrome, cytochromes and phototropins (6 lectures)
Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR).

Practical

(Marks 15)

1. Determination of isotonic concentration and osmotic pressure of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of humidity and light on the rate of transpiration in excised twig/leaf.
4. Determination of water absorption, retention and transpiration.
5. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
6. To study the phenomenon of seed germination (effect of light).

Suggested Readings

1.Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Salisbury, F. B. and Ross, C. W. – Plant Physiology. Wordsworth Publishing Company.
5. Arun Chandra Sahu (2020). Plant Physiology and Metabolism, Kalyani Publishers.
6. Stryer, L. – Biochemistry, John Wiley & Sons.
7. Taiz, L. and Zeiger, E. – Plant Physiology. The Benjamin Cumming Publishing Company.
8. V. K. Jain. Fundamentals of Plant Physiology, S. Chand Pub.

Minor 5: Plant Systematics
Course Code: S/BOT/505/MN-5
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Knowledge about appropriate method of identification of plants to contribute classification to trace the evolution and interpretation among the plants.
- Understanding the principles of general taxonomy and nomenclatural rules.
- Explanation of concept of species.
- Development of the concept to classify plants
- Recognition of the importance of herbarium, virtual herbarium and botanic garden.
- Interpretation the rules of ICN in botanical nomenclature.
- Assessment of terms and concepts related to phylogenetic systematics.

Unit 1: Significance of Plant Systematics (6 lectures)

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry. Functions of Herbarium; Important herbaria and

botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Phases of taxonomy.

Unit 2: Taxonomic hierarchy (4 lectures)
Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Unit 3: Botanical nomenclature (6 lectures)
Principles and rules (ICN); Ranks and names; Typification, author citation, effective and valid publication, rejection of names, principle of priority and its limitations.

Unit 4: Systems of classification (8 lectures)
Types of angiospermic plant classification, Broad outline, relative merits and demerits of major systems of classifications – Bentham and Hooker, and Cronquist (1988). Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit 5: Biometrics, numerical taxonomy and cladistics (8 lectures)
Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit 6: Phylogeny of Angiosperms (8 lectures)
Terms and concepts (primitive and advanced taxa, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades); Origin and evolution of angiosperms.

Unit 7: **Salient features of the following families (10 lectures)**

[Evolutionary trends need to be briefly discussed in case of families marked with asterisks]

Dicotyledons: Magnoliaceae*, Malvaceae, Brassicaceae, Fabaceae, Euphorbiaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Asteraceae*.

Monocotyledons: Alismataceae*, Poaceae, Musaceae, Orchidaceae*.

Practical

(Marks 15)

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, Section of ovary, floral diagrams, floral formula/e and identification upto the genus following any published keys.

Families: Malvaceae, Fabaceae, Apocynaceae, Asclepiadaceae, Asteraceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Euphorbiaceae.

2. **Field visits** (local and at least one distal)- Excursion/Field trips are to be organized in botanically rich areas. A field report with photographic document of plants (at least 20) and corresponding field record to be submitted during practical examination.

3. Submission of a properly dried and pressed herbarium specimen of any one wild plant.

Suggested Readings

1. College Botany Vol. III. New Central Book Agency. Calcutta.
2. Sharma, O.P. 2009. Plant Taxonomy. Mc Graw Hill Education Pvt. Ltd., India.
3. Pandey, H.P. 2010. Principles of Plant Systematics: With special reference to Current Trends in Plant Taxonomy, Lambert Academic Publishing.
4. Pandey, A.K., Khasana, S. 2021. Plant Systematics, 1st edition, CRC Press.
5. Simpson, M.G. 2019. Plant Systematics, 3rd edition, Elsevier.
6. Datta, S. C. 1991. Systematic Botany. Wiley Eastern Ltd. New Delhi, Calcutta.
7. Judd, Campbell, Kellogg. Stevens. 2003. Phylogeny & Evolution of Vascular Plants. Sinaurer Associates Inc. Publishers Sunderland. Massachusetts. USA.
8. Lawrence, G. H. M. 1981. Taxonomy of Vascular Plants. Mc Milian New York.
9. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi
10. Plant Groups. (Recent Edition). H. Mukherjee. New Central Book Agency.
11. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
12. Plant Systematics. Simpson. 2006. Elsivier. 11. S. K. Mukherjee. 1984.
13. Sachdeva, S. K. 1990. Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
14. Sporne, K. R. 1974. The Morphology of Angiosperms: The structure and evolution of flowering plants. Hutchinson University Library. London.
15. Takhtajan, A. 2009. Flowering Plants, Springer.
16. Takhtajan, A. 1986. Diversity & Plant Distribution. Oliver & Boyd.
17. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.* Cambridge University Press, Cambridge.
18. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.
19. Bhttacharya, K. Majumder, M.R. and Gupta Bhattacharya, S (2023). A Text Book of Palynology. New Central Book Agency (P) Ltd., Kolkata.

SEMESTER - VI

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/601/MJC-13	Plant Metabolism (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/602/MJC-14	Plant Biotechnology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/603/MJC-15	Industrial & Environmental Microbiology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/604/MJC-16	Natural Resource Management (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/605/MN-6	Plant Physiology & Metabolism (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
	Total in Semester - VI	**20**	**50**	**200**	**250**			

Major DSC 13: Plant Metabolism

Course Code: S/BOT/601/MJC-13

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understanding the metabolism of plants and enzymes with respect to various physiological processes.
- Explanation of chemical properties carbon compounds produced in plants
- Explanation of the significance of carbon metabolism in plants.
- Acquiring the adequate knowledge of metabolism in plants.
- Explanation of the ATP-Synthesis
- To acquiring adequate knowledge about nitrogen metabolism in plants.
- Explanation of the mechanism of signal transduction.

Unit 1: Concept of metabolism (4 lectures)
Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

Unit 2: Carbon assimilation (12 lectures)
Photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4 pathways; Crassulacean acid metabolism.

Unit 3: Carbohydrate metabolism (2 lectures)
Synthesis and catabolism of sucrose and starch.

Unit 4: Carbon Oxidation (8 lectures)
Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, TCA cycle, amphibolic role, anaplerotic reactions, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit 5: ATP-Synthesis (6 lectures)
Mechanism of ATP synthesis, oxidative and substrate level phosphorylation, chemiosmotic mechanism, ATP synthase.

Unit 6: Lipid metabolism (8 lectures)
Synthesis and breakdown of triglycerides, α oxidation and β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination.

Unit 7: Nitrogen metabolism (6 lectures)
Nitrate assimilation, biological nitrogen fixation (examples of symbiotic and non-symbiotic); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Unit 8: Mechanisms of signal transduction (4 lectures)
Receptor-ligand interactions; Second messenger concept, Calcium calmodulin.

Practical

(Marks 15)

1. Preparation of molar, molal & normal solution.
2. Chromatographic separation of photosynthetic pigments.
3. Effect of carbon dioxide on the rate of photosynthesis.
4. To compare the rate of respiration in different parts of a plant.
5. RQ of different respiratory substrate of germinating seeds.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
4. Sahu, A.C. (2020). Plant Physiology and Metabolism. Theory and Practical, Kalyani Publishers.
5. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.
6. Stryer, L. – Biochemistry, John Wiley & Sons.
7. Conn, E. E. Stumpt, P. K. Bruening, G. and Doi, R. H., Outline of Biochemistry, John Wiley & Sons.

Major DSC 14: Plant Biotechnology

Course Code: S/BOT/602/MJC-14

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understand the core concepts and fundamentals of plant biotechnology and genetic engineering
- Develop their competency on different types of plant tissue culture
- Analyze the enzymes and vectors for genetic manipulations
- Examine gene cloning and evaluate different methods of gene transfer
- Critically analyze the major concerns and applications of transgenic technology
- To learn about gene cloning, recombinant DNA technology and bioinformatics includes recent biotechnological advancement related to genomics and proteomics.
- Acquire the knowledge about gene transfer and applications of biotechnology.
- Acquire the knowledge about tissue culture techniques, restriction digestion, isolation and electrophoresis of plasmid DNA.

Unit 1: Plant Tissue Culture (14 lectures)
Historical perspective; Composition of media; Nutrient and hormone requirements; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit 2: Recombinant DNA technology (10 lectures)
Restriction Endonucleases, Types I-IV; Cloning Vectors: Prokaryotic (pUC18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, Cosmid; Eukaryotic Vectors (YAC).

Unit 3: Gene Cloning (8 lectures)
Recombinant DNA, Bacterial Transformation and selection of recombinant clones; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; colony hybridization; PCR

Unit 4: Methods of gene transfer (6 lectures)
Agrobacterium-mediated gene transfer, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment.

Unit 5: Applications of Biotechnology (12 lectures)
Pest resistant (Bt-cotton) plant; herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Practical

(Marks 15)

1. (a) Preparation of MS medium.
(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of *Datura*.
2. Study of anther, somatic embryogenesis & artificial seeds through photographs.
3. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
4. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
5. Isolation of plasmid DNA (Demonstration).

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Major DSC 15: Industrial & Environmental Microbiology
Course Code: S/BOT/603/MJC-15
Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes

- Allocation of microbes in industries and environmental management.
- Knowledge of economically important products by microbes using fermentation techniques.
- Establishment of idea using microbes in agriculture and pollution management.

Unit 1: Scope of microbes in industry and environment (4 lectures)

Unit 2: Bioreactors/Fermenters and fermentation processes (10 lectures)
Components of a typical bioreactor; Types of bioreactors- laboratory, pilot scale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and

fluidized bed bioreactors and air-lift fermenter; Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations.

Unit 3: Microbial production of industrial products (10 lectures)
Microorganisms involved, media, fermentation conditions, downstream processing and uses; Industrial production and estimation of Enzymes (Amylase and Lipase); Industrial production of Organic acid (Citric acid), Alcohol (Ethanol) and Antibiotic (Penicillin).

Unit 4: Microbial enzymes of industrial interest and enzyme immobilization (8 lectures)
Screening of microorganisms for casein hydrolysis, starch hydrolysis and cellulose hydrolysis; Methods of enzyme immobilization; Advantages and applications of enzyme immobilization; Large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase**).**

Unit 5: Microbes and quality of environment (4 lectures)
Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

Unit 6: Microbial flora of water (6 lectures)
Water pollution; role of microbes in sewage and domestic waste water treatment systems; Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality check; Coliform and fecal coliform in water samples.

Unit 7: Microbes in agriculture and remediation of contaminated soils (8 lectures)
Biological nitrogen fixation, Isolation of root nodulating bacteria; Mycorrhizae; arbuscular mycorrhizal colonization in plant roots; Bioremediation of contaminated soils.

Practical

(Practical: Marks 15)

1. Principles and functioning of instruments in microbiology laboratory.
2. Hands on sterilization techniques and preparation of culture media.
3. Measurement of BOD.
4. Study of root nodule and isolation of root nodulating bacteria.
5. Isolation of starch hydrolyzing microorganism.
6. Demonstration of a common fermenter with photograph/ picture.
7. Industrial/academic institute visit

Suggested Readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.
3. Sandikar, B.M. (2021). Fundamental Microbiology, Books & Allied (P) Ltd., Kolkata.

Major DSC 16: Natural Resource Management

Course Code: S/BOT/604/MJC-16

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understanding the idea of resources and examples of natural recourses.
- Development of the concept regarding the sustainability of using natural resources.
- Develop idea on national and international efforts in resource managements to make them sustainable.

Unit 1: Natural resources (2 lectures)
Definition and types

Unit 2: Sustainable utilization (4 lectures)
Concept, approaches (economic, ecological and socio-cultural).

Unit 3: Land (4 lectures)
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4: Water (6 lectures)
Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies, potability of water.

Unit 5: Biological Resources (10 lectures)
Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan.

Unit 6: Forests (6 lectures)
Definition, Cover and its significance (with special reference to India); Major and minor Forest products; Depletion; Management.

Unit 7: Energy (6 lectures)
Renewable and non-renewable sources of energy with examples.

Unit 8: Contemporary practices in resource management (8 lectures)
EIA, GIS, Ecological Footprint with emphasis on carbon footprint; Resource Accounting; Waste management.

Unit 9: National and international efforts in resource management and conservation (4 lectures)

Practical

(Marks 15)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Field visits to local forest/river bed/water bodies/or related field.
6. Water potability test.

Suggested Readings

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

Minor 6: Plant Physiology & Metabolism

Course Code: S/BOT/605/MN-6

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Understand Water relation of plants with respect to various physiological processes.
- Explain chemical properties and deficiency symptoms in plants.
- Classify aerobic and anaerobic respiration.
- Explain the significance of Photosynthesis and respiration.
- Assess dormancy and germination of seeds.
- To acquire adequate knowledge about translocation in plants, carbon dioxide concentrating mechanisms, growth regulators and flowering of plants.

Unit 1: Plant-water relations (6 lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2: Mineral nutrition (6 lectures)

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Translocation in phloem. (6 lectures)
Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Photosynthesis (10 lectures)
Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Unit 5: Respiration (6 lectures)
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6: Enzymes (4 lectures)
Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Nitrogen metabolism (4 lectures)
Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8: Plant growth regulators (4 lectures)
Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Unit 9: Plant response to light and temperature (4 lectures)
Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Practical

(Marks 15)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and humidity) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
5. Comparison of the rate of respiration in any two parts of a plant.

Demonstration experiments (any four)
1. Bolting; 2. Effect of auxins on rooting; 3. Suction due to transpiration; 4. R.Q.; 5. Respiration in roots.

Suggested Readings

1.Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.