



NEP SYLLABUS
FOR
FOUR YEARS UNDER-GRADUATE COURSE
IN
BOTANY
(w.e.f. 2023-2024)



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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 opportunities 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)

L O	Summary	Description
L O 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.
L O 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.
L O 3	Overall Skill	Students will be able to think logically and scientifically into structural outline, gather appropriate knowledge and skill for future career, planning and conducting independent project proposal and make appropriate report on it.
L	Team	The syllabus will enhance the development of the spirit of team work;



O 4	Work	learn to harbor collaborative approach to explore new facts and facets of the subject.
L O 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.
L O 6	Eco-friendly Approach	The course has a futuristic approach to develop eco-friendly management practices to make socio-economic upliftment.
L O 7	Ethical Awareness	Development of ethical awareness among students regarding research & publications is another outcome of the proposed course.
L O 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)	Major (4)		Minor Stream (4)	Multidisciplinary (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
	DSC	DSE								
SEMESTER										
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		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		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.	N.A.
S/BOT/304/MD-3	Herbal Technology (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
ACS/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.	N.A.
S/BOT/404/MJC-8	Economic Botany & Pharmacognosy (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	N.A.
ACS/405/MN-4	Morphology & Anatomy of Angiosperms (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	N.A.
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			

**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

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)
<u>UNIT-I</u> 1. Any five out of eight $1 \times 5 = 5$	1. Work out/Demonstration/Experiment and/or Identification: 10/9 2. Laboratory Record and/or Field record: 2/3 3. Viva Voce: 3
<u>UNIT-II</u> 2. Any two out of four $5 \times 2 = 10$	
<u>UNIT-III</u> 3. Any one out of two $10 \times 1 = 10$	

Multidisciplinary and SEC papers

Theory (F.M: 40)
<u>UNIT-I</u> 1. Any five out of eight $2 \times 5 = 10$
<u>UNIT-II</u> 2. Any four out of six $5 \times 4 = 20$
<u>UNIT-III</u> 3. Any one out of two $10 \times 1 = 10$



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)**Unit1:Algae(10lectures)**

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

Unit2:Cyanophyta,XanthophytaandBacillariophyta (6lectures)

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.

Unit3:Chlorophytaand Charophyta (6lectures)

General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas*, *Oedogonium*, *Zygnema*, *Chara*; Evolutionary significance of *Prochloron*.

Unit4:Phaeophytaand Rhodophyta (8lectures)

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia*.



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 - archaeobacteria, eubacteria, wall-less forms (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. 4th edition.
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.

Minor1: 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)**Unit1:Algae(10lectures)**

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.

Unit2:Cyanophyta,XanthophytaandBacillariophyta (6lectures)

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.



Unit3: 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*.

Unit4: 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)

Unit5: 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

Unit6: 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).

Unit7: Bacteria (10 lectures)

Discovery; general characteristics; Principles and modern approaches of bacterial taxonomy, brief outline classification of domain bacteria, Types - archaeobacteria, eubacteria, wall-less forms (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. 4th edition.
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****(Lecture 30/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 well-being 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, AktaPrakashan, Nadiad.
7. Acaharya, K., Sen, S., Rai, M. (2019) Biofertilizers and Biopesticides, Techno World, Kolkata.

SEC- 1: Biofertilizers**Course Code: S/BOT/104/SEC-1****Credit: 3****Theory****(Lecture 30/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 well-being 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, AktaPrakashan, Nadiad.
7. Acharya, K., Sen, S., Rai, M. (2019) 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.

Unit1: Introduction to fungi (4 lectures)

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

Unit2: Chytridiomycota and Zygomycota (4 lectures)

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

Unit3: Oomycota (4 lectures)

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

Unit4: Ascomycota (7 lectures)

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

Unit5: 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.

**Unit8:Symbioticassociations(4lectures)**

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.

Unit9:AppliedMycology(8Lectures)

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(8lectures)

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**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 specimen 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**: Specimen of button stage and full grown mushroom; sectioning of gills of *Agaricus*.

Phytopathology

1. **Phytopathology**: Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: Tobacco 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



6. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India
7. H.C.L. Gwynne-Vaughan 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 McGraw 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*.

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.

Unit 6: Deuteromycota (3 lectures)



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).

Unit 10: 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

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 specimen 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**: Specimen of button stage and full grown mushroom; sectioning of gills of *Agaricus*.

Phytopathology

1. **Phytopathology**: Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: Tobacco 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 Publishers India Ltd.
6. Sharma, P.D. (2011). *Plant Pathology*, Rastogi Publication, Meerut, India
7. H.C.L. Gwynne-Vaughan 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 McGraw 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.	N.A.
S/BOT/304/MD-3	Herbal Technology (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
ACS/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 archegoniatae- 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

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: Bioenergetics (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.



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

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 archegoniatae- 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

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.	N.A.
S/BOT/404/MJC-8	Economic Botany & Pharmacognosy (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	N.A.
ACS/405/MN-4	Morphology & Anatomy of Angiosperms (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	N.A.
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**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 Benjamin/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

(Practical: Marks 15/Credits 2)

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 *Acacia 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. Saunders & Co. Philadelphia.
7. Plant Ecology. R. Mishra. Oxford & IBH.
8. Sharma, P. D. Geology and Environment (10th 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.



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 selfpollinated, 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

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*, *Strychnos nux-vomica*, *Justicia adhatoda*.

Practical

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**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 Benjamin/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.