Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

Department of Botany

Examination Scheme and Syllabus

M.Sc. Botany

In accordance with NEP-2020

w.e.f. 2026-2027

(2026-27)

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

Evaluation Scheme of M.Sc. Botany
Summary

Programme	: M.Sc. Botany
Duration	: Two year (Four Semesters)
Maximum Duration	: Four Years
Medium	: English
Minimum Attendance Required	:75%
Total Credits	: 106
Total Marks	: 2250 (Option I in IV Sem.)
	: 2250 (Option II in IV Sem.)

Assessment/Evaluation

Theory examination:

Internal Marks	Major Test (End Semester Exam) Marks	Total Marks
30	70	100
15	35	50

Internal Evaluation:

Minor Test Marks	Attendance Marks	Assignment/ Quiz Marks	Total Marks
15	05	10	30
07	04	04	15

Duration of Examination:

Minor Test (Internal)	Major Test
1 hr.	3 hrs.

*There is 5% IKS in the syllabus of M.Sc. Botany including assignments.

Passing Criteria:
To qualify for the course, a student is required to secure a minimum of 40% marks in internal and external evaluation separately (End Semester Examination).
**For other details please visit University Website on PG Ordinance.

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SEMESTER-I **CREDITS: 24** **MARKS: 500**

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	Total
1.	26-BOT-101	Cell Biology	CC-1	04	-	04	04	-	04	70	30	-	100
2.	26-BOT-102	Phycology, Mycology and Plant Pathology	CC-2	04	-	04	04	-	04	70	30	-	100
3.	26-BOT-103	Bryophytes, Pteridophytes and Gymnosperms	CC-3	04	-	04	04	-	04	70	30	-	100
4.	26-BOT-104	Microbiology	DEC- 1 DEC-2 # (Select any one)	04	-	04	04	-	04	70	30		100
5.	26-BOT-105	Biodiversity and conservation											
6.	26-BOT-106	**Lab course I**	P.C.1	-	08	08	-	04	04	-	-	50	50
7.	26-BOT-107	**Lab course II**	P.C.2	-	08	08	-	04	04	-	-	50	50
TOTAL				16	16	32	16	08	24	280	120	100	500

CC = Core Course **P.C. = Practical Course**

DEC= Discipline Elective Course **# Select one out of two provided in Scheme.**

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SEMESTER II **CREDITS: 30** **MARKS: 650**

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	Total
1.	26-BOT-201	Molecular Biology	CC-4	04	-	04	04	-	04	70	30	-	100
2.	26-BOT-202	Plant Systematics and Economic Botany	CC-5	04	-	04	04	-	04	70	30	-	100
3.	26-BOT-203	Plant Biotechnology & Genetic Engineering	CC-6	04	-	04	04	-	04	70	30	-	100
4.	26-BOT-204	**Lab Course I**	P.C.-3	-	08	08	-	04	04	-	-	50	50
5.	26-BOT-205	**Lab Course II**	P.C.-4	-	08	08	-	04	04	-	-	50	50
6.	26-BOT-206	Plant Genetics	**DEC-3 DEC-4** (Select any one)	04	-	04	04	-	04	70	30	-	100
7.	26-BOT-207	Biostatistics, IPR and Biosafety											
8.	26-BOT-208	Environment Sciences (V.A.C)	VAC or I K S	02		02	02		02	35	15	- -	50
9.	26-BOT-209	Indian Knowledge Systems in Biology (IKS)											
10	26-BOT-INTERN-200	**Internship***	**SEC	Summer vacation at the end of 2nd Semester					04	----	100	-	100
TOTAL				**18**	**16**	**36**	**18**	**08**	**30**	**315**	**235**	**100**	650

CC = Core Course **SEC=Skill enhancement Course P.C. = Practical Course VAC= Value Added Course I KS= Indian Knowledge System
DEC= Discipline Elective Course # Select one out of two or student can also take MOOCs course from SWAYAM portal of equal credits.
Note: Discipline Elective Course paper can be offered depending upon the availability of the Resources and faculties. *An internship course of 4 Credits of 4-6-week duration during summer vacation after II semester is to be completed by every student. Internship can be either for enhancing the employability or for developing the research aptitude. The internship procedure and evaluation process shall be followed as per CBLU internships guidelines

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SEMESTER III CREDITS: 28 MARKS: 600

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical/ External	Total
1.	26-BOT-301	Plant Physiology	CC-7	04	-	04	04	-	04	70	30	-	100
2.	26-BOT-302	Plant Anatomy and Developmental Biology	CC-8	04	-	04	04	-	04	70	30	-	100
3.	26-BOT-303	Plant Ecology	CC-9	04	-	04	04	-	04	70	30	-	100
4.	26-BOT-304	Plant Biochemistry	DEC-5 DEC-6 D.E.C-7 #(Select any one)	04	-	04	04	-	04	70	30	-	100
5.	26-BOT-305	Restoration Ecology											
6.	26-BOT-306	Bioinformatics											
7.	26-BOT-307	**Lab course I**	P.C.-5	-	8	8	-	04	04	-	-	50	50
8.	26-BOT-308	**Lab course II**	P.C-.6	-	8	8	-	04	04	-	-	50	50
9.	26-BOT-309	Processing of Fruits and Vegetables	##E.E.C.	02	-	02	02	-	02	35	15	-	50
10	26-BOT-310	*Research Training	**SEC	During 3rd Semester for dissertation work in 4th Semester					02	----	50	-	50
TOTAL				18	**16**	**34**	**18**	**08**	**28**	**315**	**185**	**100**	**600**

C.C = Core Course, DEC=Discipline Elective Course # Select one out of three or student can also take MOOCs course from SWAYAM portal of equal credit.

Note: Discipline Elective Course paper can be offered depending upon the availability of the Resources and faculties. ** SEC- Skill Enhancement Course, ##EEC-Entrepreneurship Enhancement Course

*A Research Training of 2 Credits of 7-10 days first break of IIIrd semester is to be completed by every student. This programme will help the students for developing the research aptitude and completion of their dissertation work which is to be submitted in the 4th semester. The student will submit a synopsis on the dissertation topic of 4th Semester and will give a brief presentation at the end of third semester before the department research committee constituted for the purpose.

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SEMESTER- IV (Option I) **CREDITS: 24** **MARKS: 500**

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			Total
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	
1.	26-BOT-401	Cytogenetics and Plant Breeding	CC-10	04	-	04	04	-	04	70	30	-	100
2.	26-BOT-402	Biochemical and Biophysical Techniques	CC-11	04	-	04	04	-	04	70	30	-	100
3.	26-BOT-403	Evolutionary Biology	CC-12	04	-	04	04	-	04	70	30	-	100
4.	26-BOT-404	Seed Science and Technology	DEC-8 DEC-9 DEC-10 DEC-11 # (Select any one)	04	-	04	04	-	04	70	30	-	100
5.	26-BOT-405	Applied Mycology											
6.	26-BOT-406	Photobiology											
7.	26-BOT-407	Phytochemistry & Pharmacognosy											
8.	26-BOT-408	Lab course-I	P.C.7	-	8	8	-	4	4	-	-	50	50
9.	26-BOT-409	Lab course -II	P.C.8	-	8	8	-	4	4	-	-	50	50
TOTAL				16	16	32	16	8	24	280	120	100	500

DEC=Discipline Elective Course C.C = Core Course P.C. = Practical Course

Select one out of one or student can also take MOOCs course from SWAYAM portal of equal credit after discussion with MOOC Coordinator.

Note: Discipline Elective Course paper can be offered depending upon the availability of the Resources and faculties.

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SEMESTER-IV (Option II) **CREDTS: 24** **MARKS: 500**

Sr. No	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical/ Dissertation	Total	Theory	Internal Assessment	External/ Practical	Total
1.	26-BOT-401	Cytogenetics and plant Breeding	**DEC-12 DEC-13 DEC-14 DEC-15 DEC-16 DEC-17 DEC-18** # (Select any three)	4X3= 12	-	4x3 =12	4x3 = 12	---------	4x3 =12	70x3 = 210	30X3 =90	--------	100x3 =300
2.	26-BOT-402	Biochemical and Biophysical Techniques											
3.	26-BOT-403	Evolutionary Biology											
4.	26-BOT-404	Seed Science and technology											
5.	26-BOT-405	Applied Mycology											
6.	26-BOT-406	Photobiology											
7.	26-BOT-407	Phytochemistry Pharmacognosy											
8.	26-BOT-Disser-400	Dissertation/~~Internship~~	-	-	8	8	---	12	12	-	100	100	200
	TOTAL		-	**12**	**8**	**20**	**12**	**12**	**24**	**210**	**190**	**100**	**500**

DEC=Discipline Elective Course * The Core course of semester fourth (option I) will be treated as Discipline Elective Course (DEC) in semester fourth (option II). CC=Core Course # Select one out of three or student can also take MOOCs course from SWAYAM portal of equal.

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Note: Discipline Elective Course paper can be offered depending upon the availability of the Resources and faculties.

Program Learning outcomes (PLOs):

The Post-graduates after completion of their Masters in Botany, shall be able to learn:

PLOs	Outcomes
PLO1	Postgraduate students will be able to demonstrate and apply their knowledge to solve the real problems of the society.
PLO 2	Students will be able to develop hands on knowledge to execute their career in applied life sciences problems, which opens up the possibility of improved industry learning as well as career aspects in the future.
PLO 3	Helping the students to become a more experienced professional and building a network with other industry specialists and professionals.
PLO 4	Students will be able to comprehend three key features of biological phenomena: a) what to seek; b) how to search; and c) why to seek.
PLO 5	Viewing botany as a tool for growing the mind, critical attitude, and logical reasoning ability that is ready to assist in a variety of professions.
PLO 6	Have the capacity to develop and carry out experiments, as well as analyses and interpret data for any research project.
PLO 7	Understand the fundamental concepts of botany to grasp the variety of situations found in nature and in everyday life.

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Learning Outcome Index

Course Code	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
26-BOT-101	□√	□√	□√	□√	□√	□√	□√
26-BOT-102	□√	□√	□√	□√	□√	□√	□√
26-BOT-103	□√	□√	□√	□√	□√	□√	□√
26-BOT-104	□√	□√	□√	□√	□√	□√	□√
26-BOT-105	□√	□√	□√	□√	□√	□√	□√
26-BOT-106	□√	□√	□√	□√	□√	□√	□√
26-BOT-107	□√	□√	□√	□√	□√	□√	□√
26-BOT-201	□√	□√	□√	□√	□√	□√	□√
26-BOT-202	□√	□√	□√	□√	□√	□√	□√
26-BOT-203	□√	□√	□√	□√	□√	□√	□√
26-BOT-204	□√	□√	□√	□√	□√	□√	□√
26-BOT-205	□√	□√	□√	□√	□√	□√	□√
26-BOT-206	□√	□√	□√	□√	□√	□√	□√
26-BOT-207	□√	□√	□√	□√	□√	□√	□√
26-BOT-208	□√	□√	□√	□√	□√	□√	□√
26-BOT-209	□√	□√	□√	□√	□√	□√	□√
26-BOT-INTERN-200	□√	□√	□√	□√	□√	□√	□√
26-BOT-301	□√	□√	□√	□√	□√	□√	□√
26-BOT-302	□√	□√	□√	□√	□√	□√	□√
26-BOT-303	□√	□√	□√	□√	□√	□√	□√
26-BOT-304	□√	□√	□√	□√	□√	□√	□√
26-BOT-305	□√	□√	□√	□√	□√	□√	□√
26-BOT-306	□√	□√	□√	□√	□√	□√	□√
26-BOT-307	□√	□√	□√	□√	□√	□√	□√
26-BOT-308	□√	□√	□√	□√	□√	□√	□√
26-BOT-309	□√	□√	□√	□√	□√	□√	□√
26-BOT-310	□√	□√	□√	□√	□√	□√	□√
26-BOT-401	□√	□√	□√	□√	□√	□√	□√
26-BOT-402	□√	□√	□√	□√	□√	□√	□√
26-BOT-403	□√	□√	□√	□√	□√	□√	□√
26-BOT-404	□√	□√	□√	□√	□√	□√	□√

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26-BOT-405	□√	□√	□√	□√	□√	□√	□√
26-BOT-406	□√	□√	□√	□√	□√	□√	□√
26-BOT-407	□√	□√	□√	□√	□√	□√	□√
26-BOT-408	□√	□√	□√	□√	□√	□√	□√
26-BOT-409	□√	□√	□√	□√	□√	□√	□√
26-BOT-Disser-400	□√	□√	□√	□√	□√	□√	□√

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Cell Biology (26-BOT -101)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: **Cell Biology**

Course Code: 26-BOT-101 Course Type CC-1

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is intended to provide the basic understanding of structures and purposes of basic components of cell especially membranes, organelles, cell division and it's regulation. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Students will be able to understand cell ultrastructure and its relation to cell functions.
2. Students will learn about structure and function of various cellular organelles & cytoskeleton arrangement.
3. Students will learn about the mechanism of cellular communication and cell division pathway.
4. It will focus on the mechanism of protein localization and programmed cell death.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Introduction to Cell biology: Ultrastructure of prokaryotic & eukaryotic cells, Structural organization & function of plant cell wall. Membrane structure and function: Molecular composition of the cell membrane. Structural models of membrane, lipid bilayer and

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membrane proteins, diffusion, osmosis, ion channels, active transport, pumps, electrical properties of membranes.

UNIT-II

Structural organization and function of intracellular organelles: Mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, Nucleus; structure and organization, nuclear pores, nucleolus. Cell shape and motality: cytoskeleton, organization and role of microtubule and microfilaments, Motor movements; implications in flagella and other movements.

UNIT-III

Cellular communication: Regulation of homeostasis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. Cell cycle: Mitosis and meiosis; various stages in cell cycle, regulation and control of cell cycle, cyclin and cyclin dependent kinases.

UNIT-IV

Protein Localization: Synthesis of secretory and membrane proteins, Protein sorting and targeting of proteins into nucleus, mitochondria, chloroplast, vacuoles and peroxisomes, Exocytosis, Endocytosis, Receptor mediated endocytosis. Apoptosis (Programmed cell death); its Mechanism and inducing factors, apoptosis triggered by internal and external pathway.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Essential Cell Biology by Bruce Albert, Garland Science (2nd Ed).
2. Cell and Molecular Biology by Phillip Sheeler and Donald E. Bianchi, John Wiley and Sons (3rd Ed.).
3. The World of Cell by W. Becker, L.J. Kleinsmith and J. Hardin. Pearson Education (5th Ed.).
4. Molecular Cell Biology by Harvey Lodish, W.H. Freeman & Co (8th Ed.).
5. Cell Biology by P.S. Verma and, V.K. Agarwal, S. Chand Publishing (1st Ed.).

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Phycology, Mycology and Plant Pathology (26-BOT-102)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Phycology, Mycology and Plant Pathology

Course Code: 26-BOT-102 Course Type CC-2

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

To educate and train the students for professional and research career in the field of phycology, mycology and plant pathology. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. The students will be inspired to become aware and comprehend the broader aspects of algae.
2. The learning outcome will be aimed toward advanced academic education to broaden the knowledge of the different algal classes, ecological significance and economic importance of algae.
3. The students will be inspired to become well versed with the fungal world and their economic importance.
4. Students will learn about disease cycle on plants and different plant disease caused by microbes.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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UNIT-I

Phycology: Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization, cell ultrastructure, reproduction (vegetative, asexual and sexual), Classification of algae, criteria for classification (pigments, reserve food and flagella).

UNIT-II

Algal Classes: Overview and characteristics of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Economic importance of algae: as food, feed, in medicine and industry, Algal blooms, algal bio-fertilizers.

UNIT-III

Mycology: General characters, Organization of thallus, nutrition and reproduction; General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina; Heterokaryosis, Heterothallism, Parasexuality, Economic importance of fungi.

UNIT-IV

History of plant pathology, Various levels of parasitism, Classification of plant diseases, Pathogenesis. Plant Diseases: Causal organisms, symptoms and management of Diseases caused by Bacteria – Bacterial blight of paddy, Crown gall of stone fruits, Diseases caused by Viruses - TMV, Tristeza of Citrus, Yellow vein mosaic of Okra, Diseases caused by Mycoplasma - Sandal spike, Diseases caused by fungi - Wart of potato, Apple scab, Karnal bunt of wheat, Black, yellow and brown rust of wheat, Tikka disease of groundnut, Red rot of sugarcane, Late and early blight of potato, Downy mildew of grapes, Smut of Bajra.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Ahluwalia, A.S. (Ed.). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. 2003.
2. Becker, E.W. 1994. Microalgae - Biotechnology & Microbiology, Cambridge University Press, Cambridge,U.K.
3. Carr, N.G. & Whitton, B.A. 1982. The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
4. Dubey, R.C. 2006. Introduction to Biotechnology, Delhi Book Trust, New Delhi.
5. Dubey, R.C. 2014. Advanced Biotechnology, S Chand & Company Pvt. Ltd.,

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New Delhi.

6. Agrios, G.N. Plant Pathology. 5th Ed. Elsevier Acadmic Press, San Diego. 2005.
7. Bilgrami, K.S. and H.C. Dube. A Textbook of Modern Plant Pathology. Vikas Publishing House, New Delhi. 1990.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Bryophytes, Pteridophytes and Gymnosperm (26-BOT-103)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Bryophytes, Pteridophytes and Gymnosperm

Course Code: 26-BOT-103 Course Type CC-3

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is intended to provide the basic understanding of morphology and reproduction in Bryophytes, Pteridophytes, Gymnosperms and their Economic importance. It also provide details of the various fossil gymnosperms. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Classify and distinguish bryophytes from other groups of plants and comparative account of morphology, anatomy and reproduction of different orders.
2. Learn about different orders of pteridophytes and heterospory, origin of seed habit and evolutionary trends in stele.
3. Study life cycle and evolution of gymnosperms with detailed description of different gymnosperms orders.
4. To study fossil gymnosperms and methods of propagation of gymnosperms. It also describes the economic significance of bryophytes, pteridophytes and gymnosperms.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Introduction to Bryophyta: Morphology, structure, reproduction and life history, Evolution and distribution of sporophyte in Bryophytes. Comparative account of the morphology, anatomy and reproduction: Marchantiales, Jungermanniales, Anthoceratales, Sphagnales, Funariales and Polytrichales.

UNIT-II

Introduction to Pteridophyta: General characteristics, morphology, anatomy, reproduction andclassification of Pteridophytes. Evolution of stele and stelar system, heterospory and origin of seed habit. Comparative account of the morphology, anatomy and reproduction: Psilopsida, Lycopsida,Sphenopsida and Pteropsida.

UNIT-III

Introduction to gymnosperms: General characters, life cycle, diversity, origin andClassification, Apogamy, Apospory, Evolution of gymnosperms. Comparative account of the morphology, anatomy and reproduction: Cycadales (Cycas), Coniferales (Pinus), Ephedrales (Ephedra), Ginkgoales (Ginkgo), Welwitschiales (Welwitschia) and Gnetales (Gnetum).

UNIT-IV

General account of few fossil members: (Orders); Cycadeoidales, Pentoxylales and Cordaitales.(Families); Lyginopteridaceae, Medullosaceae, Glossopteridaceae and Caytoniaceae. Modern methods of propagation of gymnosperms: somatic embryogenesis, haploids and protoplast culture. Economic and ecological importance: Bryophytes, Pteridophytes and Gymnosperms

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Rashid, A. 1998. An Introduction to Bryophyta. Vikas Publishing House Pvt. Ltd. New Delhi.
2. Watson, E.V. 1967. The Structure and Life of Bryophytes. B.I. Publications, New Delhi.
3. Glime, J.M and Saxena D. 1991. Uses of Bryophytes. Today and Tomorrow's Printers and Publishers, New Delhi.
4. Sporne, K.R. 1985 (reprint) The Morphology of Pteridophytes. B.I. Publications Pvt. Ltd., Delhi.

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5. Sambamurty,A.V.S.S. 2005,A Text book of bryophytes, Pteriophytes, Gymnosperms and Paleobotany I.K. Int. Pvt. Ltd.
6. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New Delhi.
7. Biswas, C. and Johri, B.M. 1999. The Gymnosperms. Narosa Publishing House, New Delhi.
8. Chamberlain, C.J. 2000. Gymnosperms. C B S Publishers and Distributors, New Delhi.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Microbiology (26-BOT-104)

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany **Name of the Course: Microbiology**

Course Code 26-BOT-104 **Course Type – DEC-1**

Course Credits: 04 **Teaching Hours per week: 04**

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of Microbiology. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand the general features of Prokaryotes.

2. Explain the bacterial genome, Plasmids, bacterial culture and sterilization process.

3. Explain the general features of viruses, bacteriophages, lytic and lysogenic life cycles.

4. Explain horizontal gene transfer (transformation, transduction and conjugation).

5. Describe the agricultural Importance of Microbes-Biological Nitrogen Fixation, Mycorrhizae and Biological control of plant disease and plant pests.

6. Microbial pesticides, Bio transformations: microbial degradation of pesticides and toxic chemicals,

7. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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Unit-I

Microbial Taxonomy and Phylogeny. General features and classification of prokaryotes, size and shape, staining, cell wall and membrane system in gram positive and negative bacteria, structure of surface appendages (flagella, pili and fimbriae). Endospore formation, bacterial genome, plasmids, culture media, growth curve and reproduction, sterilization techniques.

UNIT-II

General features and classification of viruses, bacteriophage life-cycle (lytic and lysogenic), plaque assay, important plant viruses (TMV, ToLCV and CaMV), prions, viroid and virusoid. General features of actinomycetes, mycoplasmas and cyanobacteria, archaebacteria (characteristics, important members, importance and differences from bacteria).

UNIT-III

Microbial Genetics- Bacterial and Viral genomes and derived vectors; Horizontal gene transfer (transformation, transduction and conjugation), Fungal genetics – mating types and genetic exchange, heterokaryosis, parasexual cycle. Recognition and entry processes of different pathogens like bacteria and viruses into animal and plant cells. Alteration of host cell behaviour by pathogens, virus induced cell transformations.

UNIT-IV

Agricultural Importance of Microbes- Biological Nitrogen Fixation, Mycorrhizae, Biological control of plant disease and plant pests. Environmental Microbiology: Microbes and quality of environment; Distribution and implications of microbes in air- bio-aerosols, microbial flora of water, water pollution, drinking water and domestic waste treatment systems; Microbial pesticides, Bio transformations: microbial degradation of pesticides and toxic chemicals, Bio degradation of the agricultural residues, Bioremediation of contaminated soils and water. Microbes in nanotechnology, biosensors; Microbes in extreme environments.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Pelezar, MJ, Chaing, ECS & Krieg, NR (1993). Microbiology, Tata McGraw Hill Publ. New Delhi.
2. Prescott, L.M., Harley, J.P. & Klein, D.A. (1996). Microbiology Wm. C. Brown Publ. USA.
3. Ananthanarayan and Paniker's Textbook of Microbiology (2006) Orient Longman Private Limited, Hyderabad, India
4. Brock Biology of Microorganisms, Global Edition (2018), Pearson Education Limited.
5. Microbiology Question & Answer (2010) S Chand Publications, Delhi, India

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Biodiversity and conservation (26-BOT-105)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: **Biodiversity and conservation**

Course Code 26-BOT-105 Course Type DEC-2

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This paper is meant for students to gain in-depth knowledge of different levels, threats and distribution of Biodiversity and focus on the different approaches for biodiversity conservation. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Students will learn about the biodiversity and hotspots along with their importance.
2. Students will learn about the biodiversity Conservation status and strategies.
3. Students will learn about concepts of plant exploration and phytogeography. Learn about the various national and international efforts to conserve biodiversity.
4. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Biodiversity: Significance of biodiversity; levels of biodiversity- species, genetic and ecosystem diversity, threats to biodiversity; habitat loss and fragmentation, exotic species, overexploitation, endemism and extinction. Biodiversity and ecosystem services, IUCN categories of threat, Red Data Book, Hotspots: Introduction, Terrestrial and marine hotspots of biodiversity; Hottest hotspots, Hotspots of biodiversity in India.

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UNIT-II

Principles of conservation: Major approaches to biodiversity management, Biodiversity Conservation strategies; In- situ conservation; Wildlife sanctuaries, National parks, Biosphere reserves, Ex-situ conservation; Principles and practices, seed banks, field gene banks and cryobanks, Role of botanical gardens, Wetlands and Ramsar convention.

UNIT-III

Plant exploration: Basic Concept of plant introduction and invasion, National Bureau of Plant Genetic Resources (NBPGR), National Biodiversity Authority (NBA), Phytogeography: Major terrestrial biomes, Theory of island biogeography, Biogeographical zones of India, Forest types of India, Ecological and economic importance of forests, Social forestry, Desertification and Wasteland reclamation.

UNIT-IV

International and National efforts to conserve biodiversity: Convention of Biological Diversity (CBD), Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES), Indian initiatives in biodiversity conservation. United Nations Framework Convention on Climate Change (UNFCC), Kyoto Protocol and Emission Trading. Post Kyoto World: Problems and Prospects, Montreal protocol.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology (5thIndiaPvt. Ltd., New Delhi.
2. Kormondy, E.J. 2008. Concepts of Ecology. Prentice Hall of India., New Delhi.
3. Subrahmanyam, N.S. and Sambamurty, A.V.S.S. 2008. Ecology (2ndsEd.) Narosa Publishing House, New Delhi
4. Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. Ecology, Environment and Resource Conservation, AnamayaPublishers, New Delhi.
5. Stiling, P. 2009. Ecology: Theory and Applications (4Th Ed.). PHI Learning Pvt. Ltd. New Delhi.
6. Rana,S.V.S. 2009. Essentials of Ecology and Environmental Sciences (4Ed.) PHI Learning Pvt. Ltd.New Delhi.
7. A. Rosencranz and S. Divan. 2004, Environmental Law and Policy in India: Cases, Materials and Statutes.Oxford University Press, New Delhi.
8. Sahasranaman, P. B. 2009. Handbook of Environmental Law. Oxford University

Press, New Delhi, India.

9. Upadhyay, C. B.2001. Forest Laws: Central and States. Hind Publishing House, Allhabad, India.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Lab Course-1 (26-BOT-106)

(Practical Based on 26-BOT-101 and 26-BOT-102)

Maximum Marks: 50 **Practical Examination:50**

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany Name of the Course: Lab Course-1

Course Code 26-BOT-106 Course Type- P C-1

Course Credits: 04 Teaching Hours per week: 08

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

We seek to train the next generation of researchers in Cell biology and Phycology, Mycology & Pathology, with a deep understanding of core disciplines and the ability to plan important, incisive research and execute their plans with appropriate technology and methodology, from the classic to the cutting edge.

Course Outcomes (COs)

After completion of the course, students will be able to perform practical related to the course/s. Students will be able to perform practical and will develop scientific/research abilities. Students will get acquainted with various practical of Cell biology and Phycology, Mycology & Pathology,

Part C- Instructions for External Examiner:

Suggested Evaluation Methods

Evaluation is based on Practical Records, Lab Performance and Viva-voce

Maximum Marks: 50

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

List of Practical (Based on 26-BOT-101 Cell biology, 26-BOT-102 Phycology, Mycology & Pathology)

1. Study of Ultrastructure of the cell.
2. Cell staining and visualization under microscope.
3. Mitotic division in onion root tip cells.
4. Slide preparation of chromosomes.

5. Effect of different factors on cell membrane permeability.
6. Effect of tonicity on plant cells.
7. Taxonomy/ morphological study of representative members of algae- Volvox, Cladophora, Coleochaete, Oedogonium , Zygonema, Spirogyra,Chara, Vaucheria,Ectocarpus,Fucus, Polysiphonia, Nostoc, Euglena
8. To study permanent slides of Algae and Fungi.
9. To study the symptoms and diagnostic features of causal organisms and their reproductive spores by section cutting of diseased plant parts of the following plant diseases:
   - Downy mildew of grapes
   - Smut of bajra
   - Late and early blight of potato
   - Tikka disease of groundnut
   - Black rust of wheat
   - Bacterial blight of paddy
   - Red rot of sugarcane
10. Collection and submission of plant disease specimens.

*Other experiments relevant to the course.

Lab Course-II (26-BOT-107)

(Practical Based on 26-BOT-103 and 26-BOT-104/105)

Maximum Marks: 50 **Practical Examination:50**

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany Name of the Course: Lab Course-2

Course Code :26-BOT-107 Course Type- P C-2

Course Credits: 04 Teaching Hours per week: 08

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

We seek to train the next generation of researchers in 26-BOT-103 Bryophytes, Pteridophytes and Gymnosperms, 26-BOT-104 Plant Biochemistry and 26-BOT-105 Biodiversity conservation with a deep understanding of core disciplines and the ability to plan important, incisive research and execute their plans with appropriate technology and methodology, from the classic to the cutting edge.

Course Outcomes (COs)

After completion of the course, students will be able to perform practical related to the course/s. Students will be able to perform practicals and will develop scientific/research abilities. Students will get acquainted with various practicals of Plant Physiology, Plant Anatomy and Plant Embryology.

Part C- Instructions for External Examiner:

Suggested Evaluation Methods

Evaluation is based on Practical Records, Lab Performance and Viva-voce

Maximum Marks: 50

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

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List of Practical (based on 26BOT-103 Bryophytes, Pteridophytes and Gymnosperms, 26BOT-104 Plant Biochemistry and 26-BOT-105 Biodiversity conservation)

1. Taxonomy/ morphological study of representative members of Bryophytes and Pteridophytes
   - Bryophytes: Marchantia, Anthoceros, Funaria, Polytrichum, Pellia, Porella, Sphagnum.
   - Pteridophytes: Lycopodium, Selaginella, Psilotum, Equisetum, Adiantum, Marsilea,Azolla,Pteris, Ophioglossum, Dryopteris, Nephrolepis.
2. Comparative study of anatomy of vegetative and reproductive parts of Cycas, Pinus, Ginkgo,Cedrus ,Aurocaria , Ephedra, Gnetum and Taxus.
3. To study permanent slides of Bryophytes and Pteridophytes (both vegetative and reproductive phases) and Gymnosperms.
4. Collection and submission of locally available plant species (Bryophytes, Pteridophytes, Gymnosperms)
5. Detection of reducing, non-reducing and total sugars: Molisch test, Fehling's test, Benedict's test, Barfoed's test, and Iodine test.
6. Quantitative estimation of total carbohydrates by Anthrone reagent. Preparation of potato starch, its microscopic structure and solubility test.
7. Qualitative tests of protein like Biuret test, Xanthoproteic test, Ninhydrin test, Bradford's test.
8. Quantitative estimation of amino acid by using Spectrophotometer.
9. Isolation, assay and determination of specific activity of plant enzymes of germination, growth and fruit ripening, viz amylase, lipase, protease, peroxidase, polyphenol oxidase
10. Extraction and estimation of total phenols.
11. Determination of antioxidants in plant tissues – ascorbic acid, tocopherol, β – carotene
12. Understanding the concept of sampling: Random sampling, sample size, quadrat, transect and point method for the study of community structure.
13. Study the community structure using quadrate method by establishing minimum size and minimum number of quadrates.

14. Study of community structure and assessment of cover and basal area of species present and determine the IVI (Importance Value Index) of the species.
15. Study of community structure and assessing frequency of the species. Prepare a frequency diagram and divide the species into classes based on percentage frequency.
16. Study of community structure and assess the density and abundance of the species
17. Understand the concept of community coefficient by comparing the frequency of two communities.

- **Field visit/ Educational Excursion to Botanical Gardens/Herbaria/Various labs etc. and preparation of report.**

*Other experiments relevant to the course.

SEMESTER-II

Molecular Biology (26-BOT-201)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: **Molecular Biology**

Course Code: 26-BOT-201

Course Type CC-4

Course Credits: 04

Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course deals about how nucleic acids and proteins interact with in the cell to promote proper growth, division and development by the process of replication, transcription and translation. This course also emphasizes on DNA damage and repair, gene regulation. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. The students will have enhanced understanding of genome structure, evolution and its replication along with DNA repair mechanisms.
2. The students will learn mechanism of transcription and post transcriptional changes.
3. The students will learn about translation and the methods of genetic recombination.
4. The students will gain insight into the principle mechanisms of genome expression and its regulation.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT I

Replication: Evidences of DNA and RNA as the genetic material for bacteria, virus and eukaryotes, Mechanism of prokaryotic replication; Initiation, Elongation and Termination, Replicons; linear, circular and D- loops, enzymes and proteins involved in replication, Fidelity of replication and coordinating synthesis of leading and lagging strands, Okazaki fragments. DNA damage and repair: Causes of DNA damage and molecular mechanism of repair-excision repair system in bacteria and eukaryotes base excision, recombination repair systems and SOS repair.

UNIT II

Transcription and post transcription changes: Types of RNA, mRNA structure, prokaryotic and eukaryotic RNA polymerase, Transcriptional factors, promoter sequences, binding sites for RNA polymerase, transcription initiaton, promoter clearance and elongation, termination, attenuation and anti-termination, Role of Enhancers, repressors, mediators, silencers and inhibition of transcription regulation. RNA splicing and processing: Capping, polyadenylation, splicing, spliceosome, mRNA stability, Group I introns and trans-esterification, ribozymes and RNA editing.

UNIT III

Translation: Ribosome, Structure of tRNA, genetic code, Initiation; formation of initiation complex, initiation factors and their regulation, Elongation; elongation factors, amino acylation of tRNA, amino acyl tRNA synthatase, termination in prokaryotes and eukaryotes, translational inhibitor s, Co -translational and Post- translational modification of proteins.Genetic Recombination: Recombination; Types, Molecular Mechanism of Recombination, Holliday junction, Role of RecA and RecBCD enzymes, Site-specific recombination, FLP/FRT and Cre/Lox recombination.

UNIT IV

Gene Regulation: Regulation of gene expression (in viruses); Lytic and lysogenic cycle. Regulation of gene expression (in prokaryotes); Lac and Trp operons, positive and negative controls. Regulation of gene expression (in eukaryotes); Differential gene expression, regulation of chromatin structure; Histone modification, DNA methylation, Epigenetic inheritance, Regulation of transcription Initiation; Role of transcription factors, enhancers, Post transcriptional regulation, gene silencing, RNA interference; effect of miRNA and siRNA

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. J D Watson et al,2013, Molecular Biology of Gene, 7th Edition, Benjamin Cummings publishers Inc.

2. Alberts et al.2014, Molecular Biology of the Cell, 6th Edition, Garland Science.

3. Karp G.2013. Cell and molecular Biology 7th edition Wiley publication.

4. Cooper GM, Hau smann, RE.2013. The Cell –A Molecular Approach.6th edition Sinaur Associates.

5. Lolish, H., Berk, A., Zipursky, S.L., Matsudaira, P.,Baltimore, D. Darnell. J 2000 Molecular cell biology (4th edition).W.H. Freeman and Co., New York, USA

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Plant Systematics and Economic Botany (26-BOT-202)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: **Plant Systematics and Economic Botany**

Course Code: 26-BOT-202 Course Type: CC-5

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The course would deal with the basic concepts of plant taxonomy and nomenclature. The course is also designed to provide the knowledge about economic importance of various plants. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand the significance, basic concepts, tools of plant taxonomy.
2. Learn about the different systems of classification of angiosperms and detailed features of several angiosperm plant families.
3. Acquire knowledge about the plant sources of foods, fibers, medicine, oil and aroma. Along with involves innovations in meeting food demand.
4. Gain knowledge about plants yielding timber, paper, NWFPs and their role in pollution control and energy source.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit: I

Principles of Plant Classification with emphasis on modern tools of taxonomy: Taxonomy as a synthetic discipline, Modern tools of Taxonomy (Cytotaxonomy,

Chemotaxonomy, Numerical Taxonomy, Serology) Botanical Nomenclature and International Code of Botanical Nomenclature (ICBN) Important Botanical Gardens and Herbaria.

Unit: II

Systems of classification: Benthem & Hooker, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne Salient features of following families: (Monocotyledons) Orchidaceae, Liliaceae, Palmae, Cyperaceae, Araceae, and Graminae. (Dicotyledon) Ranunculaceae, Magnoliaceae, Cruciferae, Papaveraceae, Malvaceae, Leguminosae, Solanaceae, Cucurbitaceae, Umbelliferae, Compositae, Asclepediaceae, Euphorbiaceae.

Unit: III

Cultivation and uses of Important Crops: Food (cereals, pulses), forage and fodder (sorghum,bajra),Fiber yielding plants (cotton,hemp,jute), Medicinal plants (poppy, tulsi, amla, sarpgandha, ashwgandha), Oil yielding plants (mustard,coconut,groundnut,sunflower). Innovations for meeting world food demands (Green revolution, Hybridization and GM crops).

Unit: IV

General account of Important Plants: Fire-wood & Timber-yielding plants (Acacia, Teak, Eucalyptus, Casurina), Raw materials & process of paper-making, Non-wood forest products (Gums, tannins, dyes, resins). Plants used as pollution control, Plant as a source of renewable energy.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Kocchar, S.L. 1998. Economic Botany of Tropics.
2. Gupta, R.K. 1981.Systematic Botany. Atma Ram and Sons, New Delhi.
3. Pandey, S.N. and S.P. Misra. 2008. Taxonomy of Angiosperms. Ane Books, India.
4. Singh, G.Plant Systematic: 1999. Theory and Practice.Oxford and IBH Publishing Co. Pvt. Ltd. NewDelhi.
5. Sharma, O.P. 2002. Plant Taxonomy. Tata McGraw Hill Publishing Co. Pvt. Ltd., New Delhi.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Plant Biotechnology & Genetic Engineering (26-BOT-203)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: **Plant Biotechnology & Genetic Engineering**

Course Code :26-BOT-203 Course Type: CC-6

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The main objective of this course is to familiarize students with techniques of plant tissue culture, genetic manipulations of plants and quality enhancement of plant products through the use of biotechnological tools. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. The students will have better understanding of basics of plant biotechnology with emphasis on plant tissue culture.
2. The students will acquire understanding of micropropagation and distant hybridization.
3. During the course students will gain in depth knowledge about different tools and techniques of recombinant DNA technology.
4. The students will acquire understanding of production of transgenic plants for biotic and abiotic stress resistance and nutritional enrichment of crops.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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UNIT-I

Scope and basic concepts of plant biotechnology and tools. Relevance of plant biotechnology to sustainable agriculture and food security, Status of transgenic plant research in India; Terminator seed technology. Plant tissue culture: Tissue culture media preparation and sterilization techniques; Callus and suspension cultures, Concept of cellular differentiation and totipotency: Regeneration and somatic embryogenesis. Somaclonal and gametoclonal variations.

UNIT-II

Micropropagation: Methods, Applications an limitations; Production of virus free plants; Germplasm conservation; haploid plant production through plant tissue culture (Androgenesis and Gynogenesis); Distant hybridization: Embryo rescue and in vitro pollination, Somatic hybridization.

UNIT-III

Recombinant DNA technology, Tools of rDNA technology: Enzymes, Cloning vectors (Plasmids, Bacteriophages, Cosmids, Phagemids, Shuttle vectors, transposons vectors, artificial chromosomes as vector and eukaryotic vectors); Gene constructs: Promoters, Expression systems, Reporter genes. Constriction of genomic library and cDNA library, screening libraries: Polymerase Chain Reaction (PCR): Principles, technique and modifications

UNIT-IV

Gene transfer methods in plants: Plasmid mediated, electroporation, cation precipitation, liposomes, microinjection and particle gun technology, Agrobacterium mediated gene transfer: Molecular genetics of T-DNA transfer from Agrobacterium to plants Production of transgenic plant with respect to: herbicide resistance, resistance against biotic (insect, fungal and viral) and abiotic (salinity, drought, chill) factors; Nutritional quality improvement in plants for: Starch, Oil and Protein content; Golden rice and other developments.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Plant Biotechnology, B.D. Singh (2015) 3rd edition, Kalyani Publishers.
2. Plant Tissue culture: theory and practices (Vol. 5 of Studies in Plant Science) (1996) Revised edition, S.S. Bhojwani and M.K. Razdan, Elsevier Publishing.
3. Plant Biotechnology: The Genetic Manipulation of Plants (2008) 2nd edition,

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Adrian Slater Oxford.

4. Principles of gene manipulation and Genomics (2010) 8th edition, S.B Primose and R.M Twyman, Blackwell publishing.
5. Gene cloning and DNA analysis – An Introduction (2016) 7th edition, T.A. Brown, Blackwell publisher.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Lab Course-1 (26-BOT-204)

(Practical Based on 26-BOT-201 and 26-BOT-202)

Maximum Marks: 50 **Practical Examination:50**

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany Name of the Course: Lab Course-1

Course Code: 26-BOT-204 Course Type: PC- 3

Course Credits: 04 Teaching Hours per week: 08

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The course is aimed to promote the confluence of areas such as Molecular biology and Plant Biochemistry at one forum. It is also to promote and integrate research and development in the above-mentioned field. Also, to organize periodic experiments either exclusive to our lab or jointly with other organizations

Course Outcomes (COs)

After completion of the course, students will be able to perform practical related to the course/s. Students will be able to perform practicals and will develop scientific/research abilities. Students will get acquainted with various practicals of Molecular Biology, Plant Systematics and Economic Botany.

Part C- Instructions for External Examiner:

Suggested Evaluation Methods

Evaluation is based on Practical Records, Lab Performance and Viva-voce

Maximum Marks: 50

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

List of Practical (based on 26-BOT-201: Molecular Biology, 26-BOT-202: Plant Systematics and Economic Botany)

1) Isolation of Genomic DNA.
2) Isolation of plasmid DNA
3) Separation and visualization of DNA fragments by Agarose gel electrophoresis.

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4) Determination of size of DNA by comparison with DNA ladder using electrophoresis.

5) Quantitative analysis of DNA using spectrophotometer.

6) Restriction digestion of DNA and ligation of DNA fragments.

7) To study the separation of proteins with the help of electrophoresis (SDS-PAGE).

8) Study of basic structure of flower, variations, floral parts in details, floral symmetry, insertion of floral parts etc. of various angiosperm families.

9) Study of phyllotaxy in different plants

10) Morphology and anatomy of various plants:

- Food Crops: Wheat, Maize, Potato, Sugarcane.
- Fodder Crops: Sorghum, Bajra, Oat.
- Plant Fibres: Cotton, Jute
- Medicinal and Aromatic Plants: *Papaver somniferum, Catharanthus roseus, Allium sativum, Rauwolfia serpentine, Withania somnifera, Phyllanthus niruri, Aloe barbadensis, Mentha arvensis, Ricinus communis, Abutilon indicum, Datura sp., Ocimum sanctum,*
- Gums, Resins, Tannins, Dyes:

  Acacia, Terminalia, Turmaric, Indigo, Lawsonia inermis.

2. Study of angiosperm in various habitats and preparation of herbarium.
3. Prepare a list of important sources of firewood and timber in your locality.

* Field Visit Various labs/ Museum/ Botanical Gardens etc. and a Report on such survey.

***Other experiments relevant to the course.**

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Lab Course-II (26-BOT-205)

(Practical Based on 26-BOT-203 and 26-BOT-206/207)

Maximum Marks: 50 **Practical Examination:50**

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany Name of the Course: Lab Course-II

Course Code: 26-BOT-205 Course Type: PC-4

Course Credits: 04 Teaching Hours per week: 08

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The course is aimed to promote the confluence of areas such as 26-BOT-203: Plant Biotechnology & Genetic Engineering, 26-BOT-206: Plant Genetics, 26-BOT-207: Biostatistics, IPR and Biosafety at one forum. It is also to promote and integrate research and development in the above-mentioned field. Also, to organize periodic experiments either exclusive to our lab or jointly with other organizations

Course Outcomes (COs)

After completion of the course, students will be able to perform practical related to the course/s. Students will be able to perform practicals and will develop scientific/research abilities. Students will get acquainted with various practicals of 26-BOT-203: Plant Biotechnology & Genetic Engineering, 26-BOT-206: Plant Genetics, 26-BOT-207: Biostatistics, IPR and Biosafety

Part C- Instructions for External Examiner:

Suggested Evaluation Methods

Evaluation is based on Practical Records, Lab Performance and Viva-voce

Maximum Marks: 50

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

List of Practical (based on 26-BOT-203: Plant Biotechnology & Genetic Engineering, 26-BOT-206: Plant Genetics, 26-BOT-207: Bio-statistics, IPR and Bio-safety):

1. Amplification of gene using PCR.
2. Bacterial culture and antibiotic selection medias. Preparation of competent cells.
3. Transformation of bacterial cell.

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4. Preparation of plant tissue culture Media
5. Surface sterilization of explants
6. Organ culture. Induction of callus, callus propagation, Organogenesis
7. DNA isolation from plant tissues and quantitation
8. To study the separation of proteins with the help of electrophoresis (SDS-PAGE).
9. Genetic problem on gene mapping in higher plants.
10. Study of problems on Mendelian Genetics, Multiple allele and multiple gene inheritance.
11. Preparation of Linkage Maps in Diploids using three points test cross method.
12. Tetrad analysis and Centromere mapping in ordered and unordered tetrads.
13. Pedigree analysis.
14. Amplification of gene using PCR.
15. Bacterial culture and antibiotic selection medias. Preparation of competent cells.
16. Transformation of bacterial cell.
17. To study the separation of proteins with the help of electrophoresis (SDS-PAGE).
18. Genetic problem on gene mapping in higher plants.
19. Study of problems on Mendelian Genetics, Multiple allele and multiple gene inheritance.
20. Preparation of Linkage Maps in Diploids using three points test cross method.
21. Tetrad analysis and Centromere mapping in ordered and unordered tetrads.
22. Pedigree analysis.

* Other experiments relevant to the course.

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Plant Genetics (26-BOT-206)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Plant Genetics

Course Code: 26-BOT-206 Course Type: DEC-3

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is intended to provide the basic understanding of genetic, Inheritance, variation, mapping and mutation. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. The students will learn genome structure and Mendelian principles with their extensions.
2. The students will develop understanding of phenomenon of linkage and crossing over and its role in genomic imprinting.
3. The students will learn methods of gene mapping, qualitative genetics and genetic fine structures.
4. This course will impart the knowledge of basics of mutations and their importance.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Gene and DNA: Genome, gene, Double helical structure of DNA, molecular organization of chromatin. Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Extensions of Mendelian principles: Co-dominance, incomplete dominance, gene interactions.

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UNIT-II

Allelism and Linkage: Multiple Allele, Pseudo-alleles, Complementation tests, Pleiotropy, Penetrance and Expressivity, Phenocopy, Linkage and Crossing over, Sex Linkage, Sex limited and Sex influenced characters. Genomic equivalence and cytoplasmic determinants, genomic imprinting.

UNIT-III

Gene Mapping methods: Linkage maps, Tetrad analysis, Centromere mapping in linear tetrads and analysis of unordered tetrad

Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping Genetic fine structure: Cis-trans test; Dosage compensation and mechanism of sex determination in plants.

UNIT-IV

Mutations and mutagenesis: Type, causes and detection, mutant types-lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, Mutagens and their molecular mechanisms of occurrence; directed mutagenesis; DNA methylation, chemical mutagens and their effect, Ames test, mutagenesis, inspectional mutagenesis by transposons, in-vitro mutagenesis.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Robert J Brooker (2009).Genetics: Analysis and principles (III Edition).McGraw Hill.
2. Hartl DL and Jones EW (2007). Genetics-Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers.
3. Hartwell LH, Hood L,Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006). Genetics – From Genes to Genomes, 3rd edition, McGraw Hill.
4. Lewin B (2008). Genes IX, Jones and Barlerdtt Publishers.
5. Strickberger MW (2008). Genetics, 3rd Edition, Pearson (Prentice Hall).
6. Gardner E Simmons M J,Snustad D P (1991).Principles of genetics(III edition).John Wiley and Inc.
7. William S Klug, Michael R Cumming (1994). Concepts of Genetics, Prentice Hall

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Biostatistics, IPR and Biosafety (26-BOT-207)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Biostatistics, IPR and Biosafety

Course Code: 26-BOT-207 Course Type: DEC-4

Course Credits:04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The course is designed to train students in basic statistical applications in biology and introduces them regarding various types of IPR and biosafety levels and their procedure. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Students will be able to locate, analyze, evaluate and generate meaningful information from the given data.
2. The students can find career opportunities as analysts in health sciences, academics, research and Industries.
3. Understand the basic concepts, significance and agencies of Intellectual property
4. Understanding about bioethics, social and ethical implications of bioweapons. Gain knowledge about biosafety levels.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit I

Presentation of data: Types of graphs; modes of graphical representation of data; line graph; bar diagram; pie, circle and sector chart; histogram; frequency polygon; frequency curve; frequency distribution; relative and cumulative frequency distribution. Measures of

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central tendency: Mean; median; mode; empirical relationship between mean, median and mode; quartile and percentile.

Unit II

Measures of dispersion: Variability; range; mean deviation; coefficient of mean deviation; standard deviation; merits, demerits and uses of standard deviation; calculation of standard deviation. Regression analysis: Regression coefficients; properties of regression coefficients; student's t-test; chi- square test; f- test; one- and two-way ANOVA. Correlation analysis: Correlation; co-variance; calculation of co-variance; correlation analysis; correlation coefficient.

Unit III

Introduction to intellectual property: Types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge and geographical indications. Establishment and functions of GATT, WTO and WIPO; main features of TRIPS agreement; WIPO treaties and PCT. Concept of 'prior art': patent databases; basics of patents: types of patents, Indian Patent Act 1970 and recent amendments; types of patent applications: PCT and convention patent applications; patent application forms and guidelines, fee structure, time frames

Unit IV

Introduction to bioethics: Bioethical issues related to genetically-modified organisms and gene therapy/gene editing; international bioethics advisory committees and their tasks (IBC, IBA, IBS etc.); ethical issues in human cloning; ethics for using animals in research; social and ethical implications of biological weapons. Introduction to biosafety; biological safety cabinets; primary containment for biohazards; biosafety levels for microorganisms, infectious agents and infected animals; biosafety guidelines of Government of India; GMOs & LMOs

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Gupta, S.P., Statistical Methods., S. Chand & Sons, New Delhi.
2. Dhirendra Kumar et al. 2025 Emerging Trends in IPR: India and Globe, Elite publication, Delhi
3. Biostatistics by P.N. Arora and P.K. Malhan, Himalayan publishing house.
4. IPR, Biosafey and Bioethics by Deepa Goel and Somini Prashar, Pearson.
5. Biostatistical Analysis, Zar, Pearson Education India

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Environment Sciences (26-BOT-208)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Environmental Science

Course Code :26-BOT-208 Course Type: VAC

Course Credits: 02 **Teaching Hours per week: 02**

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course will provide the fundamental knowledge about environment and related issues that have direct impact on human population. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. The students will understand the environmental challenges, realizing their role and motivated to protect the environment. These learning will prepare the students to develop their queries and ideas for a healthy environment.
2. Understanding the water resource management and the concept of green energy. CO2. Understanding the different types of wastes and their management.
3. To develop awareness with the environmental laws and policies.
4. Understanding the wildlife protection and environmental impact assessment.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter

The examiner will set 5 questions asking one questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) covering the entire syllabus will be of 15 marks consisting of 3 parts of 5 marks each. The examinee will be required to attempt 3 questions in all, selecting one question from each unit of 10 marks and the compulsory question.

UNIT-I

Water Resources Management: coordinated development and management of water, land and related resources. Revival of Water Bodies: enumeration, protection and management of water bodies in their respective States. Energy & Green Technologies: Renewable and Alternative energies such as, Solar, Wind, Tidal etc.

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UNIT-II

Waste Management: Solid/Liquid/Plastic/C&D/Electronic/Bio-medical/Hazardous wastes. Sanitation & Hygiene: Methods Garbage collection, industrial/ hazardous waste management, Methods of wastewater treatment and disposal.

UNIT-III

Environmental Laws & Policies and Legal Proceedings: Legislation, regulations, policies, and permits related to protecting the environment such as The National Green Tribunal Act, 2010, Government Acts & Missions for Environment Protection & Conservation (as per National Environment Policy NEP-2020) and Ministry of Environment and Forests (MoEF).

UNIT-IV

Wildlife Protection & Conservation: habitat conservation, endangered and keystone species protection, ex-situ efforts, and poaching prevention. Environmental Impact Assessment: Water Environment, Biological Environment, Land Environment. Air Environment, Noise Environment, Socio-economic and Health Environment. Environment Management Plan.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Fundamentals of Ecology: E. P. Odum, W.B. Saunders Co. USA
2. Concepts of Environmental Science (2017): Mishra & Kumar, Rajesh Publication, Delhi, India
3. Environmental Science (6th ed) (1997): Jr. G. T. Mille r, Wadsworth Pub. Co
4. Fundamentals of Environmental Science: G. S. Dhaliwal, G. S. Sangha and P. K. Raina, Kalyani Publication
5. Environmental Science Systems & solutions, M.L. Mac-Kinney, & RM Schoch, Web-enhanced edition.
6. Environmental Chemistry: A. K. De, Wiley Eastern

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Indian Knowledge Systems in Biology (26-BOT-209)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Indian Knowledge Systems in Biology

Course Code: 26-BOT-209 Course Type: IKS

Course Credits: 02 **Teaching Hours per week: 02**

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course explores the ethical, philosophical, and interdisciplinary dimensions of Indian Knowledge Systems (IKS) in biology, emphasizing their relevance to sustainable development and modern challenges. It aims to foster a holistic approach to biological innovation. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand the ethical frameworks of IKS with its influence on modern biological practices.
2. Explore philosophical concepts of IKS and their application.
3. Gain insights into sustainable biological solutions inspired by IKS for addressing climate change and health challenges.
4. Develop an interdisciplinary perspective, integrating IKS with fields like anthropology and agriculture for innovative research.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter

The examiner will set 5 questions asking one questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) covering the entire syllabus will be of 15 marks consisting of 3 parts of 5 marks each. The examinee will be required to attempt 3 questions in all, selecting one question from each unit of 10 marks and the compulsory question.

Unit I

Ethical Frameworks in IKS: Ethical principles in IKS: Ahimsa (non-violence) and its influence on genetic engineering, animal cell culture and GM crops. Ethical considerations in modern biology inspired by traditional practices. Case studies on ethical dilemmas in biological research.

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Unit II

Philosophical Dimensions of IKS: Concept of inter connected ness: Pancha-mahabhuta (five elements) and Tridosha (body balance) in understanding biological systems. Implications for gene editing and stem cell therapy. Samkhya philosophy and concepts of consciousness in guiding ethical biological practices.

Unit III

Philosophy and Spirituality in Biology: Integration of philosophical concepts of Prana (life force) and spiritual symbolism of plants/animals in drug design and regenerative medicine. Role of IKS in shaping holistic approaches to biological research and innovation.

Unit IV

Interdisciplinary Applications and Modern Relevance: Sustainable development through IKS: Insights in Pharmacognosy, bioenergy, and biodiversity for addressing climate change and health challenges. Interdisciplinary approaches: Integration of IKS with anthropology (Ethano-medicine), Agriculture for innovations and environmental solutions.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Sushruta Samhita, translated by Kaviraj Kunjalal Bhishagratna, Chowkhamba Sanskrit Series.
2. Charaka Samhita, translated by P.V. Sharma, Chaukhambha Orientalia.
3. Indian Philosophy by S. Radhakrishnan, Oxford University Press.
4. Ethnomedicine and Pharmacognosy by V.K. Singh and J.N. Govil, Studium Press.
5. Biotechnology and Traditional Knowledge by S.K. Jain, Oxford & IBH Publishing.
6. Environmental Biotechnology by Bimal C. Bhattacharyya, Oxford University Press.
7. Bioethics and Biosafety by M.K. Sateesh, I.K. International Publishing House.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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INTERNSHIP* (26-BOT-INTERN-200)

Maximum Marks: 100 **Internal Assessment: 100**

Time: 3 hours

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany Course Type SEC

Name of the Course: Internship* Course Credits: 04

Course Code: 26-BOT-INTERN- 200

Teaching Hours: No Teaching Hours , this has to be done in Summer vacation of 2nd semester

An internship course of 4 Credits of 4-6 weeks duration during summer vacation after 2nd semester is to be completed by every student. Internship can be either for enhancing the employ-ability or for developing the research aptitude.

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SEMESTER-III

Plant Physiology (26-BOT-301)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Plant Physiology

Course Code: 26-BOT-301

Course Type: CC-7

Course Credits: 04

Teaching Hours per week: 04

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of plant physiological and biochemical processes with emphasis on water relations, mineral nutrition, photosynthesis, respiration, phytohormones, stress physiology, and signal transduction. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Explain the mechanisms of water absorption, translocation, mineral uptake, and nutrient utilization in plants.
2. Describe the biochemical and physiological basis of photosynthesis, respiration, and energy metabolism.
3. Interpret the role of phytohormones and secondary metabolites in plant growth, development, and stress adaptation.
4. Analyze plant responses to abiotic and biotic stresses and evaluate physiological adaptation strategies.
5. Photobiology, dormancy, and environmental regulation of plant development.
6. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Plant water relations and Mineral Nutrition: Concept and components of diffusion, osmosis, DPD and water potential, uptake, transport and translocation of water, ions and solutes from soil, through cells, across membrane and through xylem. Transpiration and factors affecting transpiration, anti-transpirants, Role and mode of action of micro and macronutrients, deficiency disorders.

Photo assimilate Translocation: Mechanism of Phloem loading, Mass Flow through phloem and phloem unloading at sink of photo assimilates.

UNIT-II

Photosynthesis: Light harvesting complex, Photo protective mechanisms, Photo-oxidation of water, cyclic and non-cyclic photophosphorylation, photorespiration and its significance. The sequence of reactions in photosynthesis, carbon Dioxide Fixation- C3, C4 cycles and CAM pathways. Factors affecting photosynthesis, Blackman's law of limiting factors.

2. **Accumulation and Partitioning of Photosynthates**: Formation and mobilization of chloroplast starch, sucrose biosynthesis, transport and signaling.

UNIT-III

Respiration: Mechanism and regulation of glycolysis, Underground metabolism in glycolytic pathway, Krebs cycle (with reference to plant specific reactions), Plant mitochondrial electron Transport and ATP synthesis, alternate oxidase, Photorespiratory Pathway, pentose phosphate pathway (PPP) and glyoxylate Pathway.

2.Nitrogen Metabolism: Biochemistry of nitrogen fixation, symbiotic and free-living nitrogen fixation, formation of root nodule in legumes, Nitrogenase, nitrate reductase, nitrate assimilation, ammonium assimilation (major and alternate route), transamination reactions, amino acid biosynthesis.

UNIT-IV

Plant Hormones and stress Physiology: Biosynthesis, storage, breakdown and transport of plant Growth Regulators (PGRs), Physiological effects, agriculture applications and mechanism of action of plant hormones. Physiological and molecular responses of plants to abiotic (drought, salinity, heat, cold and oxidative stress) and biotic stresses (Plant-Pathogen interactions and insect resistance mechanisms), innate immunity.

Sensory Photobiology and Secondary Metabolites: Light perception, structure, function and mechanisms of action of phytochromes, cytochromes and phototropins, stomatal

movements, Tropic movements, photoperiodism, Dormancy and Vernalization and biological clocks. Biosynthesis of terpenes, phenolics, alkaloids, phenylpropanoids, nitrogenous compounds and their roles, metabolic engineering in plants.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). Biochemistry (9th ed.). W. H. Freeman.

2. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.

3. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.

4. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). Plant Physiology and Development(6th ed.). Sinauer Associates.

5. Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to Plant Physiology (4th ed.). Wiley.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Plant Anatomy and Developmental Biology (26-BOT-302)

Part A: Introduction Programme and Course

Name of Programme M.Sc. Botany

Name of the Course: Plant Anatomy and Developmental Biology

Course Code: 26-BOT-302 Course Type: CC-8

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of plant anatomy and Plant developmental Biology with emphasis on plant tissue structure and function, embryogenesis and development of male and female gametophytes in angiosperms. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. explain the structure of various types of plant tissues and their locations and functions.
2. Describe the mechanism of secondary growth and anomalous secondary growth.
3. Explain the process of embryogenesis and roles of phytohormones in embryogenesis.
4. Differentiate between male and female gametophytes.
5. understand the seed and fruit development and seed germination.
6. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit-I

Meristem classification, permanent tissues, complex tissues (xylem and Phloem), secretory tissues, epidermal tissue system, types of vascular bundles, anatomy of monocotyledonous and dicotyledonous stems and roots, root-stem transition.

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Anatomy of monocotyledonous and dicotyledonous leaves, secondary growth (tissues and mechanism involved), types of wood (storied and non-storied, ray structure, tyloses, canals), anomalous secondary growth with examples.

UNIT-II

Organization of shoot and root apical meristem, shoot and root development, leaf development and phyllotaxy, transition to flowering, floral meristem, organogenesis and floral development, radial patterning, origin of epidermis, procambial precursors, SAM and RAM differentiation and maintenance, vascular cambium.

UNIT-III

Microsporogenesis and development of male gametophyte in Angiosperms. Megasporogenesis and development of female gametophyte in Angiosperms, pollination and its types, pollen-pistil interaction, Incompatibility.

Embryo sac development and double fertilization in plants, endosperm development and its types, Embryogenesis, polyembryony and apomixis, seed and fruit formation and seed germination.

UNIT-IV

Establishment of symmetry in plants, origins of polarity patterning during embryogenesis, position dependent mechanisms, genetic basis of embryogenesis, mutant analysis, role of phytohormones. Programmed cell death, ageing and senescence in plants.

Recommended Books/e-resources/LMS:

1. Esau, K. (2006). Plant Anatomy (3rd ed.). John Wiley & Sons.
2. Esau, M. (2019). Plant Anatomy. Springer.
3. Esau, M. (2005). Introduction to Plant Anatomy (Rev. ed.). John Wiley & Sons.
4. Went, F. W. (1970). Plant Embryology (2nd ed.). Van Nostrand Reinhold.
5. Gerstel, S. A., & Waller, D. G. (2000). Plant Embryology: A Morphological Approach.
6. Bhojwani SS, Bhatnagar SP and Dantu PK (2015) :The Embryology of Angiosperms

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Plant Ecology (26-BOT-303)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Plant Ecology Course Type: CC-9

Course Code 26-BOT-303 Course Credits: 04

Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of plant ecology with special emphasis on ecosystem ecology, population ecology, community ecology and biodiversity. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand the ecological levels of organization (population, community, ecosystem and biosphere).

2. Explain the structure of ecosystems, community structure (food chains, food webs, trophic levels), keystone species and species interactions.

3. Explain the population growth models, Life-history strategies and r-and K selection, concept of metapopulation-demes and dispersal, interdemic extinctions, age structured populations.

4. Explain ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

5. Understand the community structure and various types of interactions in the community.

6. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire

syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Introduction to Ecology-History, levels of organization (Individual, population, community, ecosystem, biosphere), approaches to study ecology and scope. The Environment: Solar radiations and temperature, Biotic and abiotic factors, ecological adaptations, ecotype, tolerance range and limiting factors, soil as a reservoir of life.

Ecosystem organization: structure and functions; primary production (Global pattern and controlling factors); energy dynamics, energy flow pathways and ecological efficiencies. Decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P, & S, ecosystem stability (resistance and resilience).

UNIT-II

Population ecology- Concept, characteristics, population growth, logistic growth and density dependent and density independent factors, life tables, survivorship curves; population dynamics- Age structure, sex ratio, life history strategies (r-selected vs. K- selected); Metapopulations- Habitat fragmentation, connectivity and extinction risks, age structured populations. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

UNIT-III

Community Ecology- Community structure and organization; food chains, food webs, trophic levels, keystone species, species interactions- Mutualism, Competition, predation, competition, parasitism and allelopathy, Nature of communities, community structure and its attributes; species diversity, Edges and ecotones, vegetation characteristics (analytical and synthetic characters, methods of analysis.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax/Community stability.

UNIT-IV

Human Impacts and Biodiversity Conservation- Invasion of alien plants: Concept, ecological impact and management. Anthropogenic pressures: Land use and land cover changes, Climate Change, Environmental pollution.

Threats to biodiversity, IUCN categories of threats, Conservation genetics, Population viability Analysis (PVA), In-situ and Ex-situ conservation strategies, Community based

conservation and the role of Indigenous knowledge. International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA). Protection of Plant Varieties and Farmers' Rights (PPVFR) Act, 2001, Conservation strategies for seed gene banks.

Part-D Recommended Books/e-resources/LMS:

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.

2. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.

3. Mishra & Kumar (2017), Concepts of Environmental Science, Rajesh Publications, New Delhi, India

4. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.

5. Steffen, W., A. Sanderson, P. D. Tyson, J. Jager, P. M. Matson, B. Moore, III, F. Oldfield, K. Richardson, H.J. Schellenberg, B. L. Turner, II, and R. J. Wasson. 2004. Global change and the Earth system: A Planet under Pressure. Springer-Verlag, New York, New York, USA Reference books.

6. Townsend, C.R., Begon, M. And Harper, J.L. 2003. Essentials of Ecology. Second Edition. Blackwell Publishing, Oxford.

7. Jakhar, S. (2024). Fundamentals of Ecology. TechSar, New Delhi.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Plant Biochemistry (26-BOT-304)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Plant Biochemistry

Course Code: 26-BOT-304 Course Type: DEC-5

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The course has been designed to train students with the knowledge of various biomolecules and their synthesis with metabolism. In addition, the course also deals with different biochemical tests to identify various biomolecules. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. This course will impart the knowledge of principles of biochemistry and bioenergetics.
2. The students will be able to increase the understanding about enzymes, amino acids & proteins.
3. During the course students will learn about structure, classification and metabolism of carbohydrates and lipids.
4. The students will be able to increase the understanding about Nitrogen & Sulphur metabolism and structure & functions of vitamins.
5. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Principles of Biochemistry: Structure of atom, molecules, forces stabilizing macromolecules, weak bonds and covalent bonds, buffers and pKa values. Bioenergetics: Principles of thermodynamics, free energy, chemical and redox potential, Structure and function of ATP, Exergonic and endergonic reaction, Entropy and energy.

UNIT-II

Fundamentals of enzymology: General aspects, nature of enzyme catalysis, enzyme kinetics, enzyme regulation and inhibition, isozymes, Allosteric enzyme and cofactors. Amino acids and Proteins: Structure types, properties and Metabolism of Amino acids; Primary, Secondary, Tertiary and Quaternary structure of proteins; Domains, motif and folds; Stability of protein structure; Classification of proteins based on composition, solubility function; Reverse turns and Ramachandran plot.

UNIT-III

Carbohydrates: Structure and classification. Metabolism of carbohydrates (polysaccharide, glycoprotein and peptidoglycan); Stereoisomerism, transformation of carbohydrates, synthesis and degradation of sucrose, starch and cellulose Lipids: Composition, structure and classification, Biosynthesis and oxidation of structural and storage lipids.

UNIT-IV

Nitrogen fixation and N & S metabolism: Overview of biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation. Sulfate uptake, transport and assimilation. Vitamins: structure and function of Thiamine, Riboflavin, Nicotinic Acid, Pantothenic Acid, Pyridoxine, Biotin, Folic Acid, Vitamin B12, Ascorbic Acid, Vitamin A, D, E and K.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Lehninger, A. Principles of Biochemistry. Worth Publishers. 1011 pp. 1982.
2. Voet, D. and J.G. Voet. Biochemistry. 3 rd Ed. John Wiley & Sons Inc. 1264 pp. 2008.
3. Jain, J.L., N. Jain and S. Jain. Fundamentals of Biochemistry. S. Chand & Co. Ltd., New Delhi. 1264pp. 2007.
4. Nelson, D.L. & M.M. Cox. Lehninger's Principles of Biochemistry. 5th Ed. W.H. Freeman& Co., USA.1100 pp. 2008.
5. Palmer, T. Enzymes Biochemistry, Biotechnology, Clinical Chemistry. Affiliated East – West Press Pvt. Ltd. 2004.

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6. Plummer, D.T. An Introduction to Practical Biochemistry, 2nd Ed. T.M.H. Publishing Co., New Delhi.352pp.1979.

7. Prince, N.C and L. Stevens. Fundamental of Enzymology. Oxford University Press, Oxford. 1984.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Restoration Ecology (26-BOT-305)

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany

Name of the Course: Restoration Ecology

Course Code: 26-BOT-305

Course Type: DEC-6

Course Credits: 04

Teaching Hours Per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of plant physiological and biochemical processes with emphasis on water relations, mineral nutrition, photosynthesis, respiration, phytohormones, stress physiology, and signal transduction. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand the importance of ecological restoration and strategies of Restoration.

2. Explain restoration plans and rehabilitation measures.

3. Explain various natural and anthropogenic disturbances.

4. Understand prevention and mitigation of invasive species, habitat fragmentation and ecosystem stability.

5. Explain the degradation and restoration of forest and grassland ecosystems.

6. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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Unit-I

Restoration-Terms and definitions, Importance of ecological restoration: strategies of Restoration- Natural recovery, active restoration, rehabilitation.

Restoration plan and rehabilitation measures. Natural and anthropogenic disturbances: Characteristics and sources, effects on structural and functioning of terrestrial and aquatic ecosystems.

Unit-II

Rehabilitation of salt affected soils, Prevention and mitigation of invasive species; Habitat fragmentation. Ecosystem stability: Structural and functional stability, Climate change mitigation and Biological carbon sequestration.

Unit- III

Sustainable forestry management and agroforestry, Biotechnological Tools of Restoration, Environmental impact and risk assessment.

Unit-IV

Degradation and Restoration of forest and grassland ecosystems. Degradation and restoration of aquatic resources: River corridors, wetlands and lakes

Adaptive restoration of wetlands; Waste water recycling and waste management. Reclamation of mining sites, Bioremediation and Phytoremediation.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.

2. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.

3. Mishra & Kumar (2017), Concepts of Environmental Science, Rajesh Publications. New Delhi, India

4. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.

5. Steffen, W., A. Sanderson, P. D. Tyson, J. Jager, P. M. Matson, B. Moore, III, F. Oldfield, K. Richardson, H.J. Schnellnhuber, B. L. Turner, II, and R. J. Wasson. 2004. Global change and the Earth system: a Planet under Pressure. Springer-Verlag, New York, New York, USA Reference books.

6. Townsend, C.R., Begon, M. And Harper, J.L. 2003. Essentials of Ecology. Second Edition. Blackwell Publishing, Oxford.

8. Jakhar, S. (2024). Fundamentals of Ecology. TechSar, New Delhi.

Bioinformatics (26-BOT-306)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany
Name of the Course: Bioinformatics
Course Code: 26-BOT-306
Course Type: DEC-7
Course Credits: 04
Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of plant physiological and biochemical processes with emphasis on water relations, mineral nutrition, photosynthesis, respiration, phytohormones, stress physiology, and signal transduction. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Explain scope of bioinformatics, biological databases (primary databases, secondary and specialized databases).

2. Know the advantages and disadvantages of biological databases, sequence retrieval from databases (NCBI, Phytozome, SOL Genomics, TAIR and other plant specific databases).

3. Explain the sequence alignment, pairwise sequence alignment, sequence homology, sequence identity, sequence similarity, global and local alignment, alignment algorithms.

4. Explain the gene, promoter and regulatory element prediction programs for prokaryotes and eukaryotes (with reference to plant genomes).

5. Describe phylogenetic trees (concept and programme), protein and RNA structure prediction.

6. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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Unit-I

Introduction and scope of bioinformatics, biological databases (primary databases, secondary and specialized databases), advantages and disadvantages of biological databases, sequence retrieval from databases (NCBI, Phytozome, SOL Genomics, TAIR and other plant specific databases).

Unit-II

Sequence alignment, pairwise sequence alignment, sequence homology, sequence identity, sequence similarity, global and local alignment, alignment algorithms (dot matrix method and dynamic programming methods), scoring matrices, statistical significance of sequence alignment.

Unit-III

Heuristic algorithms for performing database searches, types of BLAST, multiple sequence alignment, Markov and Hidden Markov Models, PSI BLAST, protein motif and domain prediction, motif and domain databases, plant protein family databases.

Unit-IV

Gene, promoter and regulatory element prediction programs for prokaryotes and eukaryotes (with reference to plant genomes), gene expression databases (data retrieval and processing from SOL Genomics, Phytozome), phylogenetic trees (concept and programme), protein and RNA structure prediction.

Part D-Learning Resources

Recommended Books/e-resources/LMS:

1. Lesk, A. M. (2008). Introduction to Bioinformatics. Oxford University Press.

2. Choudhuri, S. (2014). Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools. Academic Press.

3. Edwards, D. (Ed.). (2016). Plant Bioinformatics: Methods and Protocols. Humana Press.

4. Rashidi, H. H., & Buehler, L. K. (2017). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press.

5. Compeau, P., & Pevzner, P. (2014). Bioinformatics Algorithms: An Active Learning Approach. Active Learning Publishers.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Lab Course-1 (26-BOT-307)

(Practicals Based on 26-BOT-301 and 26-BOT-302)

Maximum Marks: 50 **Practical Examination:50**
Time: 6 Hours

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany Name of the Course: Lab Course-1

Course Code: 26-BOT-307 Course Type: P C-5

Course Credits: 04 Teaching Hours per week: 08

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The practical course is designed to make the students fully acquainted with various tools and procedures for various practicals. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to perform practicals related to the course/s. Students will be able to perform practicals and will develop scientific/research abilities. Students will get acquainted with various practicals of Plant Physiology, Plant Anatomy and Plant Embryology.

Part C- Instructions for External Examiner:
Suggested Evaluation Methods
Evaluation is based on Practical Records, Lab Performance and Viva-voce

Maximum Marks: 50

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

List of Practical (Based on 26-BOT-301 Plant Physiology)

1. Compare the rate of Transpiration in different conditions using potometer.
2. Study of stomatal frequency and stomatal index.
3. Determination of nitrate reductase activity.
4. Separation of chlorophyll pigments by paper chromatography/TLC.
5. Estimation of chlorophyll (Arnon's method).
6. Measurement of photosynthetic rate using leaf disc method.

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7. Hill reaction using isolated chloroplasts.
8. Measurement of respiration rate using Ganong's respirometer.
9. Effect of gibberellins on seed germination and stem elongation.
10. Assay of amylase activity during seed germination.
11. Determination of electrolyte leakage under stress.
12. Effect of salt stress on seedling growth.
13. Determination of membrane permeability using beetroot tissue.
14. Effect of temperature and solvents on membrane permeability.
15. Estimation of carbohydrate by Anthrone method.

List of practical (Based on 26-BOT-302 Plant Anatomy and Developmental Biology)

1. Double staining of permanent sections (Safranin–Fast Green). and mounting of permanent slides using DPX or Canada balsam.
2. Study of shoot apical meristem/ root apical meristem.
3. Identification of parenchyma, collenchyma, and sclerenchyma.
4. Study the anatomy of Root, Stem and Leaves of dicots and monocot using permanent slides.
5. Study of Secondary growth, annual rings and wood anatomy.
6. Study of stomatal index and stomatal frequency.
7. Identification of fibres and tracheids.
8. To study the structure of young and mature anther.
9. To study Microsporogenesis, stages of Pollen grain development and pollen morphology.
10. To study pollen viability tests.
11. To study pollen germination in vitro.
12. To study various types of ovules with permanent slides
13. To isolate and perform microscopic identification of different stages of embryo development.

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Lab Course-II (26-BOT-308)

(Practical Based on 26-BOT-303 and DEC Course 26-BOT-304,305,306 and 309)

Maximum Marks: 50 **Practical Examination:50**
Time: 6 Hours

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany
Course Code: 26-BOT-308
Course Credits: 04
Name of the Course: Lab Course-II
Course Type: P C -6
Teaching Hours per week: 08

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

The practical course is designed to make the students fully acquainted with various tools and procedures for various practicals. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations

Course Objectives

Course Outcomes (COs)

After completion of the course, students will be able to perform practicals related to the course/s and will develop scientific/research abilities. Students will get acquainted with various practicals of Plant Ecology, Microbiology, Bioinformatics and Processing of Fruits and Vegetables.

Part C- Instructions for External Examiner:
Suggested Evaluation Methods
Evaluation is based on Practical Records, Lab Performance and Viva-voce

Maximum Marks: 50

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

List of Practicals based on 26-BOT-303, 26-BOT-304, 26-BOT-305,26-BOT-306 and 26-BOT-309)

1. To study the methods of sampling in ecological studies.
2. To determine the minimum size of the quadrat by species area curve method.
3. To study the density and abundance of plants at a given location by quadrat method.

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4. To determine the distribution of plants in a given area of vegetation by quadrat method.
5. Compare the anatomical and morphological adaptations of Hydrophytes, Xerophytes and Halophytes.
6. Preparation and sterilization of culture media for Bacteria Culture.
7. Preparation of nutrient agar, potato dextrose agar (PDA), and Czapek-Dox medium.
8. Isolation and culture of microorganisms from soil, water, and air.
9. To study serial dilution technique.
10. Streak plate method for obtaining pure cultures.
11. Gram staining and differential staining of bacteria.
12. Observation of fungi using Lactophenol Cotton Blue.
13. Colony morphology studies.
14. Isolation of nitrogen-fixing bacteria/Isolation of Rhizobium from root nodules.
15. To perform soil texture analysis, Soil pH determination, soil electrical conductivity measurement.
16. Study of Nursery techniques for native plants.
17. Seed collection and storage.
18. Vegetative propagation of native species.
19. Identification of fruits and vegetables suitable for processing.
20. To study preservation Techniques (Solar drying, Tray drying., Osmotic dehydration, refrigerated storage studies, Freezing techniques and preparation of dehydrated vegetables). Preparation of fruit juice.
21. To study the preparation of squash, syrup, nectar, cordial, jam, fruit preserve, candy etc.
22. To study preparation of tomato ketchup, tomato sauce, tomato puree, pickles etc.
23. Preparation of Fermented Products (sauerkraut, pickles, vinegar etc.)

***Other experiments relevant to the course.**

Processing of Fruits and Vegetables (26-BOT-309)

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany

Name of the Course: Processing of Fruits and Vegetables

Course Code: 26-BOT-309 Course Type: EEC

Course Credits: 02 Teaching Hours per week: 02

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of fruit and vegetable processing. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to process the fruits and vegetables and will be able to preserve the processed fruits and vegetables.

Part C- Instructions for Paper Setter:

The examiner will set 5 questions asking one questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 2 parts covering the entire syllabus. The examinee will be required to attempt 3 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Post-harvest handling (harvesting, sorting, grading and packing and transportation) of fruits, vegetables and flowers, post-harvest treatments (pre-cooling, hot water, hot air and vapour heat, fungicide & biologically safe chemicals, irradiation, curing, pulsing etc.) for quality retention of horticultural crops, fruit ripening and ethylene management.

UNIT-II

On farm storage (evaporative cooled stores, ventilated storage, pit storage etc.), refrigerated storage, controlled / modified atmosphere storage, hypobaric, hyperbaric storage. Contamination and spoilage of fresh fruits, vegetables and processed products.

UNIT-III

Principles and methods of preservation, processing of fruits and vegetables (canning, drying and dehydration, fruit beverages and juice concentrates, sugar based products, tomato

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products, fermented products, value added products etc.), food additives, minimal processing, packaging techniques and storage system for processed products.

UNIT-IV

Importance of quality, quality management standards, ISO/BIS, PFA, AGMARK, HACCP, Codex Alimentarius, total quality management (TQM), food standards (FPO, PFA etc.), food laws and regulations.

Part D-Learning Resources

Recommended Books/e-resources/LMS

1. Hui, Y.H. (2008). Handbook of fruit and vegetable processing. Wiley India Pvt. Ltd., New Delhi.

2.Sharma, S.K. (2010). Postharvest management and processing of fruits and vegetables. New India Publishing Agency, New Delhi.

3. Sharma, S.K. and Nautiyal, M.C. (2009). Postharvest technology of horticultural crops. New India Publishing Agency, New Delhi.

4.. Wills, R.B.H, McGlasson, W.S, Graham, D. and Joyce, D.C. (2009). Postharvest: An introduction to the physiology and handling of fruits, vegetables and ornamentals. CABI International, Cambridge, USA.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Research Training (26-BOT-310)

Type of Course: Skill Enhancement Course

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Research Training

Course Code: 26-BOT-310 Course Type: SEC

Course Credits: 02 **Teaching Hours per week: 04**

*A Research Training of 2 Credits of 7-10 days first break of IIIrd semester is to be completed by every student. This programme will help the students for developing the research aptitude and completion of their dissertation work which is to be submitted in the 4th semester. The student will submit a synopsis on the dissertation topic of 4th Semester and will give a brief presentation at the end of third semester before the department research committee constituted for the purpose.

SEMESTER-IV

M.Sc. Botany Syllabus 4th Semester (Batch 2026-28) Option-1
(For students Opting Lab Course I and Lab Course-II)

Cytogenetics and Plant Breeding (26-BOT-401)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Cytogenetics and Plant Breeding

Course Code: 26-BOT-401 Course Type: CC-10

Course Credits: 04 Teaching Hours per week: 04

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The purpose of this paper is to acquaint the students about structure and functions of a chromosome in detail. The course also explains the chromosomal variations and their effects on biological system. Further, it aims to draw attention to methods used for crop improvement. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Know the role of chromosomes and chromosomal rearrangements in generation of variations.
2. They will also be familiar with methods used to change the traits of a plant to create the desired genotype/phenotype.
3. Understand various methods of crop improvement.
4. Methods of breeding in self- and cross-pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding
5. Methods of breeding of vegetative propagated crops; Non-conventional methods of plant breeding, polyploidy, gene variability.
6. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire

syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Chromatin structure and organization: Molecular organization of chromatin, centromere and telomere; Euchromatin and heterochromatin. Nucleosomes, DNA Packaging.

Karyotype analysis; Chromosome banding technique (Q, G and R Banding and their uses); Flow cytometry and Confocal microscopy in karyotype analysis,

Specialized types of chromosomes: Polytene, Lampbrush, B chromosomes and sex chromosomes.

UNIT-II

Extrachromosomal Inheritance: The Genetics of Plastids, mitochondria and chloroplasts.

Structural alterations in chromosomes–Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes.

Variation in chromosome number: Haploids, aneuploids and euploids- origin, production, effects and uses; polyploidy and crop improvement, Meiotic behaviour and use of trisomics, monosomics and nullisomics in chromosome

UNIT-III

Principles of plant breeding: Principles and objectives; methods of breeding self- and cross-pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding. Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses,

UNIT-IV

Asexual Breeding Systems: Methods of breeding of vegetative propagated crops; Non-conventional methods; polyploidy; gene variability. **Male Sterility**: Concept, Types, Genetic control and Breeding utility, Self-incompatibility, clonal selection **Multigene families**: Multigene families and their evolution. Centers of Origin of crops, biodiversity and its significance.

Part- D Recommended Books/e-resources/LMS:

1. George Acquaah 2012 Principles of Plant Genetics and Breeding
2. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
3. Lewin B (2010) Gene X, Jones and Barlett Publishers.

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4. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
5. Russell PJ (2006) Genetics (5th Ed.), Addison Wesley Longman, California, USA.
6. Snustad P and Simmons MJ (2011) Principles of Genetics. (6th Ed.), John Wiley, New York.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Biochemical and Biophysical Techniques (26-BOT-402)

Part A: Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Biochemical and Biophysical Techniques

Course Code: 26-BOT-402 Course Type: CC-11

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This paper aims to provide an introduction to various tools and techniques used to gain insight into cell structure and biological processes. The focus is on studying the techniques used for isolation, purification and characterization of bio molecules.

The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. This paper is expected for students to gain in-depth knowledge of numerous methods used in characterization the biomolecules.

2. Understand the principles and applications of various types of microscopes.

3. Understand various modern tools and their applications like Chromatography, Electrophoresis, spectroscopy and tracer techniques.

4. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, Confocal microscope, scanning and transmission electron microscopes. Different fixation and staining techniques (Preparation of permanent slides).

Centrifuge technique: Principle, Types of centrifuge, Density gradient centrifuge, differential centrifugation and Ultra centrifugation.

UNIT-II

Chromatography: Principles and Types; Paper chromatography, Thin layer Chromatography, Gel filtration Chromatography, Ion-exchange Chromatography, Affinity Chromatography, Gas chromatography and High-Pressure Liquid Chromatography (HPLC) and FPLC. Application of chromatographic technique in biology.

Electrophoresis: Principles and applications of Agarose, Polyacrylamide gel electrophoresis, 2D Gel Electrophoresis, Differential in-gel Electrophoresis (DIGE), Electrophoretic Mobility Shift Assay (EMSA)

UNIT-III

Spectroscopy: UV, visible, Infra-red, Fluorescence, Atomic absorption spectroscopy, NMR and ESR spectroscopy; Mass spectrometry (LC-MS, GC-MS), X-ray diffraction. Surface Plasmon Resonance (SPR), Flow cytometery

Tracer Biology: Nature and types of radiation, preparation of labeling biological sample, Safety measurement in handling radioisotopes detection and measurement of radiation, GM counter, Scintillation counter Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography. Application of different spectroscopic technique in biology.

Unit- IV

Immunotechniques: Detection of molecules using, ELISA, RIA, Western blot and Immuno precipitation, In-situ localization by techniques as Fluorescence In-situ Hybridization (FISH) and Genomic In-situ Hybridization (GISH).

Quantification and quality determination of RNA and DNA, Micro array (DNA and protein)

Part- D Recommended Books/e-resources/LMS:

1. Wilson K and Walker J (2018) Principles and Techniques of Biochemistry and Molecular Biology (8th Ed.), Cambridge University Press, New Delhi.

2. Sawhney SK and Singh R (2000) Introductory Practical Biochemistry (Ed.), Narosa Publishing House Pvt. Ltd., New Delhi.

3. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.

4. Hegyi G, Kardos J, Kovacs M, Csizmadia AM, Nyitray L, Pal G, Radnai L, Remenyi A Venekei I (2013) Introduction to Practical Biochemistry, EotvosLorand University, Hungary.

5. Plummer DT (1990) An Introduction to Practical Biochemistry, Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.

6. Ranade R and Deshmukh S (2013) Handbook of Techniques in Biotechnology, Studium Press (India) Pvt. Ltd. New Delhi.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Evolutionary Biology (26-BOT- 403)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Evolutionary Biology

Course Code: 26-BOT-403 Course Type: CC-12

Course Credits: 04 Teaching Hours per week: 04

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The aim of this course is to provide students with a deeper insight into the evolutionary process including origin and evolution of organisms and also about population genetics. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand the evidences, theories and molecular basis of evolution.

2. Understand the Concepts of neutral evolution, molecular divergence.

3. Know about molecular clocks, molecular tools in phylogeny, protein and nucleotide sequence analysis, origin of new genes and proteins; gene duplication and divergence.

4. Understand various aspects of population genetics and speciation.

5. Understand how evolution helps us to solve biological problems that impact our life.

6. . Researchers can also understand evolutionary pattern of hereditary disease in people and by treating them they can improve the quality of human life.

7. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part-C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT- I

Emergence of evolutionary thoughts: Lamarckism, Darwinism–concepts of variation, adaptation, struggle, fitness and natural selection, Mendelism, spontaneity of mutations, the evolutionary synthesis. **Origin of cells and unicellular evolution:** Origin of basic biological molecules. abiotic synthesis of organic monomers and polymers, concept of Oparin and Haldane, Experiment of Miller (1953)

UNIT-II

Origin and Evolution of prokaryotic and eukaryotic cells, anaerobic metabolism, photosynthesis and aerobic metabolism.

Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks, molecular tools in phylogeny, protein and nucleotide sequence analysis, origin of new genes and proteins; gene duplication and divergence.

UNIT-III

Biological diversity: Species and classification, Phylogenetic trees, Geological fundamentals, Phylogeny and the fossil record, Evolutionary trends, Rates of evolution, Major patterns of distribution, phytogeography, Sources of phenotypic variation, Genetic variation in populations, Variation among populations.

UNIT-IV

Population genetics: Populations, gene pool, gene frequency, Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift, adaptive radiation and modifications; isolating mechanisms, speciation (allopatric and sympatric), convergent evolution, sexual selection, co-evolution.

Part- D Recommended Books/e-resources/LMS:

1. David Briggs, Stuart Max Walters (1997). Plant Variation and Evolution, Cambridge University Press.

2. Douglas J. Futuyma (1998). Evolutionary Biology (3rd Edition), Sinauer Associates.

3. Mark Ridley (2003) Evolution (3rd edition), Blackwell.

4. Roderic D. M. Page, Edward C. Holmes (1998). Molecular Evolution: A Phylogenetic Approach, Blackwell.

5. Scott R, Freeman and Jon C. Herron (2003). Evolutionary Analysis

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Seed Science and Technology (26-BOT-404)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Seed Science and Technology

Course Code: 26-BOT- 404 Course Type: DEC-8

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of seeds like seed production, hybrid seeds, seed quality control and seed certification. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand the principles and practices of seed production, including hybrid seed techniques and the role of seed industry stakeholders in India.
2. Learn the objectives and procedures of seed quality control, including seed testing methods and standards, as well as the importance of moisture content and purity standards.
3. Explore the factors affecting seed viability, vigour, and longevity, along with the physiological basis of seed vigour and its impact on crop performance.
4. Gain insights into seed certification regulations, seed processing principles, and the operation of seed processing machinery, essential for maintaining seed quality and standards.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No.1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Seed production: seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, Agro-climatic requirements and their influence on quality seed production, certification standards, use of male sterility and self-incompatibility and CHA in hybrid seed production, seed village concept; seed production agencies, seed industry and custom seed production in India.

UNIT-II

Seed quality: objectives, concept and components and their role in seed quality control, instruments, devices and tools used in seed testing, ISTA and its role in seed testing, procedure of seed sampling, sampling intensity, methods of preparing composite and submitted samples, sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, prescribed seed purity standards, importance of moisture content, equilibrium moisture content, methods of seed germination testing.

UNIT-III

Seed viability and longevity, pre and post-harvest factors affecting seed viability, seed ageing, physiology of seed deterioration, lipid peroxidation and other viability theories, means to prolong seed viability, mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield.

UNIT-IV

Central Seed Certification Board (CSCB), the Seed Act (1966), Seed Rules (1968), New Seed Bill-2004, Indian Minimum Seed Certification Standards (I.M.S.C.S), principles of seed processing, functions of scalper debearder, scarifier, huller, seed cleaner, grader, screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.

Part- D Recommended Books/e-resources/LMS:

1. ISTA. (2019). ISTA Handbook on Seedling Evaluation (3rd ed.). International Seed Testing Association.

2. Basra, A. S. (2017). Seed Science and Technology (3rd ed.). CRC Press.

3. McDonald, M. B., & Copeland, L. O. (2019). Seed Production: Principles and Practices (2nd ed.). CABI.

4. Smith, R. D., & Dickson, M. H. (2018). Seed Technology and Its Biological Basis (2nd ed.). CRC Press.

5. Vanangamudi, K., & Swaminathan, M. S. (2016). Seed Science and Technology: Theory and Practice (4th ed.). Agrobios Publications.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Applied Mycology (26-BOT-405)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Applied Mycology

Course Code: 26-BOT-405 Course Type- DEC-9

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of Fungi and its various applications in agriculture and industry. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Know about the production of Valuable microbial products.
2. Understand the role of Fungi as bio fertilizers and biocontrol agents.
3. Become familiar with techniques used for maintenance of fungal cultures.
4. Use the knowledge of mycology for commercial production of mushrooms.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit I

Primary metabolites production by fungi: industrial alcohol, organic acid, beer. Secondary metabolites production by fungi: Antibiotics, steroid transformation, enzymes, amino acids, growth regulators, vitamins.

Unit II

Fungi as biofertilizers: Endomycorrhiza and ectomycorrhiza. Fungi as biocontrol of plant pathogens and weeds. Biodeterioration of materials: Paper, painted surface, wood. Role of fungi in biogeochemical cycle.

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Unit III

Food processing by fungi: Bread, cheese, oriental food and baker's yeast. Fungal sources of health food: Single cell protein, edible mushrooms. Spoilage of food and fungal toxicity.

Unit IV

Culturing and preservation of fungi: isolation of fungi, culturing of fungi, establishing a pure culture, aseptic technique, maintenance of culture collection, culture collection and identification centers. Common culture media and sterilization techniques.

Part-D Recommended Books/e-resources/LMS:

1. Deacon, J. W. (2013). Fungal Biology (5th ed.). John Wiley & Sons.

2. Gadd, G. M. (2007). Fungi in Biogeochemical Cycles (2nd ed.). Cambridge University Press.

3. Moore-Landecker, E. (2009). Fundamentals of the Fungi (4th ed.). Prentice

4. Hall. Dighton, J., White, J. F., & Oudemans, P. (2005). The Fungal Community: Its Organization and Role in the Ecosystem (3rd ed.). CRC Press.

5. Sutton, B. C. (2012). The Fungi: An Advanced Treatise (2nd ed., Vol.)

6. Dhirendra Kumar, et.al (2025) Mushroom Magic: Biochemistry and Nutritional Value of Fungi", published by CRC Press (Taylor & Francis) United Kingdom

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Photobiology (26-BOT-406)

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany Course Type- DEC -10

Name of the Course: Photobiology Course Code: 26-BOT-406

Course Credits: 04 Teaching Hours per week: 04

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of various aspects of light on the plant life. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Learning Outcomes (CLOs)

1.Students will understand light characteristics and plant photoreceptors, including phytochrome and cryptochrome structures and functions.

2.Students will learn about circadian rhythm control by ZEITLUPE and the roles of phototropins and UVR8 in plant responses to light.

3.Students will explore light-hormone interactions in plant growth, development, and stress responses, focusing on phototropism and photomorphogenesis.

4.Students will gain knowledge of key experiments and concepts in photosynthesis, including photosystems, the Z-scheme, and various photosynthetic pathways.

UNIT-I

Characteristics of light, plant photoreceptors and its classification, phytochrome structure and action potential, phytochrome responses (VLFR, LFR, HIR), phytochrome signaling pathways (gene regulation by PIFs, COP regulation), blue light kinetics, cryptochrome structure and action potential, CRY-COP interaction.

UNIT-II

Control of circadian rhythm by ZEITLUPE, phototropins structure and action potential, role of phototropins in chloroplast movement and stomatal opening, UVR8 structure and action potential, responses to UV radiation and molecular mechanism of UVR8 function.

UNIT-III

Light-hormone interplay in phototropism, photomorphogenesis, chlorophyll biosynthesis, defense and development, molecular mechanism of shade avoidance, role of yellow and green light in growth, development, shade avoidance and stress responses, mechanisms of sensing and responding to light stress in plants.

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UNIT-IV

Key experiments in understanding photosynthesis, antenna system, photosystems, Z-scheme, repair and regulation of photosynthetic machinery, genetics, assemble and evolution of photosynthetic systems, C3 cycle, RuBisCO regulation, photorespiration, C4, CAM and SAM photosynthesis.

Part- D Recommended Books/e-resources/LMS:

1.Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2023). Plant physiology and development (7th ed.). Sinauer Associates.

2.Mohr, H., & Schopfer, P. (2020). Plant physiology (2nd ed.). Springer.

3.Kochhar, S. L., & Gujral, S. K. (2020). Plant physiology: Theory and applications (2nd ed.). Cambridge University Press.

4.Nobel, P. S. (2020). Physicochemical and Environmental Plant Physiology (5th ed.). Academic Press.

5.Pessarakli, M. (Ed.). (2024). Handbook of plant and crop physiology (4th ed.). CRC Press (Routledge).

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Phytochemistry and Pharmacognosy (26-BOT-407)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Phytochemistry and Pharmacognosy

Course Code: 26-BOT-407 Course Type: DEC-11

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of Phytochemistry and Pharmacognosy. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Understand protein and non-protein amino acids, protein structure and sequencing, special forms of DNA and RNA including isolation and purification techniques.
2. Know about carbohydrates including their classification, structure, properties, types and functions.
3. Understand the roles of water-soluble and fat-soluble vitamins.
4. Explore Pharmacognosy, the classification and evaluation of crude drugs, and the structure and classification of secondary metabolites.
5. Gain knowledge on source plants, parts used, and uses of various bio active compounds, along with commonly used extraction methods.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Protein and non-protein amino acids, Ramachandran plot, protein (levels of organization), protein sequencing and assays, protein isolation and purification. Special forms of DNA (triplex and G-quadruplex), DNA denaturation and quantification, supercoiling, DNA

isolation and purification. RNA world hypothesis, RNA stability and thermodynamics, RNA isolation and purification.

UNIT-II

Carbohydrates (classification, structure and optical properties), reducing and non-reducing sugars, monosaccharide derivatives (sugar alcohols, sugar acids, glycosides and amino sugars), disaccharides (glycosidic bond with examples and sucrose hydrolysis), polysaccharides (homo and hetero), glycoproteins. Water soluble and fat soluble vitamins (biosynthetic precursors and roles).

UNIT-III

Pharmacognosy and its importance in modern medicine, crude drugs, classification of drugs (chemical and pharmacological), drug evaluation (organoleptic, microscopic, chemical, physical and biological), classification and structure of secondary metabolites (terpenes, phenolics and N-containing).

UNIT-IV

Source plant parts used and uses of solasodin, diosgenin, digitoxin, catechin, gingerol, curcuminoids, paclitaxel, quinine, atropine. pilocarpine, strychnine, reserpine, vinblastine, sennoside and capsaicin and the most commonly used methods of their extraction.

Part-D Recommended Books/e-resources/LMS:

1.Berg, J. M., Tymoczko, J. L., & Stryer, L. (2022). Biochemistry (10th ed.). W. H. Freeman.

2. Voet, D., Voet, J. G., & Pratt, C. W. (2020). Fundamentals of biochemistry: Life at the molecular level (6th ed.). Wiley.

3. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W. H. Freeman.

4. Evans, W. C. (2020). Trease and Evans' pharmacognosy (19th ed.). Elsevier.

5. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). Pharmacognosy (56th ed.). Nirali Prakashan.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Lab Course-I (26-BOT-408)

(Practical Based on 26-BOT-401 and 26-BOT-402)

Maximum Marks: 50 Total Marks: 50
Time: 6 Hours

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany Name of the Course: Lab Course-1

Course Code: 26-BOT-408 Course Type: PC-7

Course Credits: 04 Hours per week: 08

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The practical course is designed to make the students fully acquainted with various tools and procedures for various practical. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to perform practical related to the course/s.

Part C- Instructions for Paper Setter:

Maximum Marks: 50

Duration: 6 Hours

Evaluation scheme in Lab Course (Practical) examination:

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

List of Practical (from 26-BOT-401,26-BOT-402)

1. Understanding the concept of sampling: Random sampling, sample size, quadrat, transect and point method for the study of community structure.
2. Study the community structure using quadrate method by establishing minimum size and minimum number of quadrates.
3. Study of community structure and assessment of cover and basal area of species present and determine the IVI (Importance Value Index) of the species
4. Study of community structure and assessing frequency of the species. Prepare a frequency diagram and divide the species into classes based on percentage frequency

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5. Study of community structure and assess the density and abundance of the species
6. Understand the concept of community coefficient by comparing the frequency of two communities.
7. Demonstration of Chromatography i.e. TLC, HPLC, GC.
8. To demonstrate the separation of proteins with the help of electrophoresis (SDS-PAGE).
9. To demonstrate the separation of DNA with the help of electrophoresis (AGE)
10. To study various molecular biology techniques i.e. PCR,ELISA,RIA
11. Purification of protein by Column Chromatography.
12. Preparation of plant tissue culture Media

***Other experiments relevant to the course.**

Lab Course-II (26-BOT-409)

Practical Based on any two courses (26-BOT-403,26-BOT-404, 26-BOT-405, 26-BOT-406, 26-BOT-407)

Maximum Marks: 50 **Total Marks: 50**
Time: 6Hours

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany — Name of the Course: Lab Course-II

Course Code: 26-BOT- 409 — Course Type: P C - 8

Course Credits: 04 — Teaching Hours per week: 08

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The practical course is designed to make the students fully acquainted with various tools and procedures for various practical. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to perform practical related to the course/s.

Part C- Instructions for Paper Setter:

Maximum Marks: 50

Evaluation scheme in Lab Course (Practical) examination:

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

List of Practical (26-BOT-403, 26-BOT-404, 26-BOT-405, 26-BOT-406, 26-BOT-407)

1. Surface sterilization of explants
2. Organ culture. Induction of callus, callus propagation, Organogenesis
3. DNA isolation from plant tissues and quantitation
4. Amplification of gene using PCR.
5. Bacterial culture and antibiotic selection medias. Preparation of competent cells.
6. Transformation of bacterial cell.
7. Study of Angiosperm fossil record with the help of chart/model.
8. Study of Phenotypic morphological variation: Intraspecific variation in size and shape of leaves of various angiosperm groups
9. Study of problems on population size fluctuations with respect to migration.

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10. Study of phylogenetic tree of Angiosperms with chart.
11. Effect of Light Intensity on Photosynthesis
12. Effect of Light Quality (Color) on Photosynthesis
13. Effect of UV Radiation on Seed Germination
14. Stomatal Opening in Light and Darkness
15. Isolation and quantification of chlorophyll and carotenoids.
16. Measurement of photosynthetic pigments using spectrophotometry.
17. Morphological identification of medicinal plants.
18. Preparation of plant extracts using Cold maceration, Hot extraction, and Soxhlet extraction.
19. Preliminary Phytochemical Screening: Test for alkaloids (Dragendorff's, Wagner's, Mayer's tests), Test for flavonoids, Test for tannins, Test for saponins, Test for glycosides, Test for terpenoids and steroids, Test for phenolics, Test for carbohydrates, Test for proteins and amino acids.
20. Demonstration of Chromatography i.e. TLC, HPLC, GC.
21. Thin Layer Chromatography (TLC) profiling of plant extracts.
22. Paper chromatography of amino acids or sugars.

***Other experiments relevant to the course.**

M.Sc. Botany Syllabus 4th Semester (Batch 2026-28) Option-II (For students who are opting Dissertation Work)

Cytogenetics and Plant Breeding (26-BOT-401)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Cytogenetics and Plant Breeding

Course Code: 26-BOT-401 Course Type: CC-12

Course Credits: 04 Teaching Hours per week: 04

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The purpose of this paper is to acquaint the students about structure and functions of a chromosome in detail. The course also explains the chromosomal variations and their effects on biological system. Further, it aims to draw attention to methods used for crop improvement. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

6. Know the role of chromosomes and chromosomal rearrangements in generation of variations.
7. They will also be familiar with methods used to change the traits of a plant to create the desired genotype/phenotype.
8. Understand various methods of crop improvement.
9. Methods of breeding in self- and cross-pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding
10. Methods of breeding of vegetative propagated crops; Non-conventional methods of plant breeding, polyploidy, gene variability.
6. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

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The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Chromatin structure and organization: Molecular organization of chromatin, centromere and telomere; Euchromatin and heterochromatin. Nucleosomes, DNA Packaging.

Karyotype analysis; Chromosome banding technique (Q, G and R Banding and their uses); Flow cytometry and Confocal microscopy in karyotype analysis,

Specialized types of chromosomes: Polytene, Lampbrush, B chromosomes and sex chromosomes.

UNIT-II

Extrachromosomal Inheritance: The Genetics of Plastids, mitochondria and chloroplasts.

Structural alterations in chromosomes–Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes.

Variation in chromosome number: Haploids, aneuploids and euploids- origin, production, effects and uses; polyploidy and crop improvement, Meiotic behaviour and use of trisomics, monosomics and nullisomics in chromosome

UNIT-III

Principles of plant breeding: Principles and objectives; methods of breeding self- and cross-pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding. Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

UNIT-IV

Asexual Breeding Systems: Methods of breeding of vegetative propagated crops; Non-conventional methods; polyploidy; gene variability. **Male Sterility**: Concept, Types, Genetic control and Breeding utility, Self-incompatibility, clonal selection **Multigene families**: Multigene families and their evolution. Centers of Origin of crops, biodiversity and its significance.

Part- D Recommended Books/e-resources/LMS:

7. George Acquaah 2012 Principles of Plant Genetics and Breeding
8. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.

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9. Lewin B (2010) Gene X, Jones and Barlett Publishers.
10. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
11. Russell PJ (2006) Genetics (5th Ed.), Addison Wesley Longman, California, USA.
12. Snustad P and Simmons MJ (2011) Principles of Genetics. (6th Ed.), John Wiley, New York.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Biochemical and Biophysical Techniques (26-BOT-402)

Part A: Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Biochemical and Biophysical Techniques

Course Code: 26-BOT-402 Course Type: CC-13

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This paper aims to provide an introduction to various tools and techniques used to gain insight into cell structure and biological processes. The focus is on studying the techniques used for isolation, purification and characterization of bio molecules.

The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

5. This paper is expected for students to gain in-depth knowledge of numerous methods used in characterization the biomolecules.

6. Understand the principles and applications of various types of microscopes.

7. Understand various modern tools and their applications like Chromatography, Electrophoresis, spectroscopy and tracer techniques.

8. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, Confocal microscope, scanning and transmission electron microscopes. Different fixation and staining techniques (Preparation of permanent slides).

Centrifuge technique: Principle, Types of centrifuge, Density gradient centrifuge, differential centrifugation and Ultra centrifugation.

UNIT-II

Chromatography: Principles and Types; Paper chromatography, Thin layer Chromatography, Gel filtration Chromatography, Ion-exchange Chromatography, Affinity Chromatography, Gas chromatography and High-Pressure Liquid Chromatography (HPLC) and FPLC. Application of chromatographic technique in biology.

Electrophoresis: Principles and applications of Agarose, Polyacrylamide gel electrophoresis, 2D Gel Electrophoresis, Differential in-gel Electrophoresis (DIGE), Electrophoretic Mobility Shift Assay (EMSA)

UNIT-III

Spectroscopy: UV, visible, Infra-red, Fluorescence, Atomic absorption spectroscopy, NMR and ESR spectroscopy; Mass spectrometry (LC-MS, GC-MS), X-ray diffraction. Surface Plasmon Resonance (SPR), Flow cytometery

Tracer Biology: Nature and types of radiation, preparation of labeling biological sample, Safety measurement in handling radioisotopes detection and measurement of radiation, GM counter, Scintillation counter Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography. Application of different spectroscopic technique in biology.

Unit- IV

Immunotechniques: Detection of molecules using, ELISA, RIA, Western blot and immuno precipitation, In-situ localization by techniques as Fluorescence In-situ Hybridization (FISH) and Genomic In-situ Hybridization (GISH).

Quantification and quality determination of RNA and DNA, Micro array (DNA and protein)

Part- D Recommended Books/e-resources/LMS:

1. Wilson K and Walker J (2018) Principles and Techniques of Biochemistry and Molecular Biology (8th Ed.), Cambridge University Press, New Delhi.

2. Sawhney SK and Singh R (2000) Introductory Practical Biochemistry (Ed.), Narosa Publishing House Pvt. Ltd., New Delhi.

3. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.

4. Hegyi G, Kardos J, Kovacs M, Csizmadia AM, Nyitray L, Pal G, Radnai L, Remenyi A Venekei I (2013) Introduction to Practical Biochemistry, EotvosLorand University, Hungary.

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5. Plummer DT (1990) An Introduction to Practical Biochemistry, Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.

6. Ranade R and Deshmukh S (2013) Handbook of Techniques in Biotechnology, Studium Press (India) Pvt. Ltd. New Delhi.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Evolutionary Biology (26-BOT- 403)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Evolutionary Biology

Course Code: 26-BOT-403 Course Type: CC-14

Course Credits: 04 Teaching Hours per week: 04

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

The aim of this course is to provide students with a deeper insight into the evolutionary process including origin and evolution of organisms and also about population genetics. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

7. Understand the evidences, theories and molecular basis of evolution.

8. Understand the Concepts of neutral evolution, molecular divergence.

9. Know about molecular clocks, molecular tools in phylogeny, protein and nucleotide sequence analysis, origin of new genes and proteins; gene duplication and divergence.

10. Understand various aspects of population genetics and speciation.

11. Understand how evolution helps us to solve biological problems that impact our life.

12. . Researchers can also understand evolutionary pattern of hereditary disease in people and by treating them they can improve the quality of human life.

7. Develop analytical and conceptual skills required for higher studies and competitive examinations such as UGC-NET, CSIR-NET, GATE, and ICAR examinations.

Part-C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT- I

Emergence of evolutionary thoughts: Lamarckism, Darwinism–concepts of variation,

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adaptation, struggle, fitness and natural selection, Mendelism, spontaneity of mutations, the evolutionary synthesis. **Origin of cells and unicellular evolution:** Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin and Haldane, Experiment of Miller (1953)

UNIT-II

Origin and Evolution of prokaryotic and eukaryotic cells, anaerobic metabolism, photosynthesis and aerobic metabolism.

Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks, molecular tools in phylogeny, protein and nucleotide sequence analysis, origin of new genes and proteins; gene duplication and divergence.

UNIT-III

Biological diversity: Species and classification, Phylogenetic trees, Geological fundamentals, Phylogeny and the fossil record, Evolutionary trends, Rates of evolution, Major patterns of distribution, phytogeography, Sources of phenotypic variation, Genetic variation in populations, Variation among populations.

UNIT-IV

Population genetics: Populations, gene pool, gene frequency, Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift, adaptive radiation and modifications; isolating mechanisms, speciation (allopatric and sympatric), convergent evolution, sexual selection, co-evolution.

Part- D Recommended Books/e-resources/LMS:

1. David Briggs, Stuart Max Walters (1997). Plant Variation and Evolution, Cambridge University Press.

2. Douglas J. Futuyma (1998). Evolutionary Biology (3rd Edition), Sinauer Associates.

3. Mark Ridley (2003) Evolution (3rd edition), Blackwell.

4. Roderic D. M. Page, Edward C. Holmes (1998). Molecular Evolution: A Phylogenetic Approach, Blackwell.

5. Scott R, Freeman and Jon C. Herron (2003). Evolutionary Analysis

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Seed Science and Technology (26-BOT-404)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Seed Science and Technology

Course Code: 26-BOT- 404 Course Type: DEC- 15

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of seeds like seed production, hybrid seeds, seed quality control and seed certification. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

5. Understand the principles and practices of seed production, including hybrid seed techniques and the role of seed industry stakeholders in India.
6. Learn the objectives and procedures of seed quality control, including seed testing methods and standards, as well as the importance of moisture content and purity standards.
7. Explore the factors affecting seed viability, vigour, and longevity, along with the physiological basis of seed vigour and its impact on crop performance.
8. Gain insights into seed certification regulations, seed processing principles, and the operation of seed processing machinery, essential for maintaining seed quality and standards.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No.1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Seed production: seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, Agro-climatic requirements and their influence on quality seed production, certification standards, use of male sterility and self-incompatibility and CHA in hybrid seed production, seed village concept; seed production agencies, seed industry and custom seed production in India.

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UNIT-II

Seed quality: objectives, concept and components and their role in seed quality control, instruments, devices and tools used in seed testing, ISTA and its role in seed testing, procedure of seed sampling, sampling intensity, methods of preparing composite and submitted samples, sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, prescribed seed purity standards, importance of moisture content, equilibrium moisture content, methods of seed germination testing.

UNIT-III

Seed viability and longevity, pre and post-harvest factors affecting seed viability, seed ageing, physiology of seed deterioration, lipid peroxidation and other viability theories, means to prolong seed viability, mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield.

UNIT-IV

Central Seed Certification Board (CSCB), the Seed Act (1966), Seed Rules (1968), New Seed Bill-2004, Indian Minimum Seed Certification Standards (I.M.S.C.S), principles of seed processing, functions of scalper debearder, scarifier, huller, seed cleaner, grader, screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.

Part- D Recommended Books/e-resources/LMS:

1. ISTA. (2019). ISTA Handbook on Seedling Evaluation (3rd ed.). International Seed Testing Association.

2. Basra, A. S. (2017). Seed Science and Technology (3rd ed.). CRC Press.

3. McDonald, M. B., & Copeland, L. O. (2019). Seed Production: Principles and Practices (2nd ed.). CABI.

4. Smith, R. D., & Dickson, M. H. (2018). Seed Technology and Its Biological Basis (2nd ed.). CRC Press.

5. Vanangamudi, K., & Swaminathan, M. S. (2016). Seed Science and Technology: Theory and Practice (4th ed.). Agrobios Publications.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Applied Mycology (26-BOT-405)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Applied Mycology

Course Code: 26-BOT-405 Course Type- DEC-16

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of Fungi and its various applications in agriculture and industry. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

5. Know about the production of Valuable microbial products.

6. Understand the role of Fungi as bio fertilizers and biocontrol agents.

7. Become familiar with techniques used for maintenance of fungal cultures.

8. Use the knowledge of mycology for commercial production of mushrooms.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit I

Primary metabolites production by fungi: industrial alcohol, organic acid, beer. Secondary metabolites production by fungi: Antibiotics, steroid transformation, enzymes, amino acids, growth regulators, vitamins.

Unit II

Fungi as biofertilizers: Endomycorrhiza and ectomycorrhiza. Fungi as biocontrol of plant pathogens and weeds. Biodeterioration of materials: Paper, painted surface, wood. Role of fungi in biogeochemical cycle.

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Unit III

Food processing by fungi: Bread, cheese, oriental food and baker's yeast. Fungal sources of health food: Single cell protein, edible mushrooms. Spoilage of food and fungal toxicity.

Unit IV

Culturing and preservation of fungi: isolation of fungi, culturing of fungi, establishing a pure culture, aseptic technique, maintenance of culture collection, culture collection and identification centers. Common culture media and sterilization techniques.

Part-D Recommended Books/e-resources/LMS:

7. Deacon, J. W. (2013). Fungal Biology (5th ed.). John Wiley & Sons.

8. Gadd, G. M. (2007). Fungi in Biogeochemical Cycles (2nd ed.). Cambridge University Press.

9. Moore-Landecker, E. (2009). Fundamentals of the Fungi (4th ed.). Prentice

10. Hall. Dighton, J., White, J. F., & Oudemans, P. (2005). The Fungal Community: Its Organization and Role in the Ecosystem (3rd ed.). CRC Press.

11. Sutton, B. C. (2012). The Fungi: An Advanced Treatise (2nd ed., Vol.)

12. Dhirendra Kumar, et.al (2025) Mushroom Magic: Biochemistry and Nutritional Value of Fungi", published by CRC Press (Taylor & Francis) United Kingdom

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Photobiology (26-BOT-406)

Part A – Introduction Programme and Course

Name of Programme M.Sc. Botany Course Type- DEC -17

Name of the Course: Photobiology Course Code: 26-BOT-406

Course Credits: 04 Teaching Hours per week: 04

Part B- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of various aspects of light on the plant life. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Learning Outcomes (CLOs)

1.Students will understand light characteristics and plant photoreceptors, including phytochrome and cryptochrome structures and functions.

2.Students will learn about circadian rhythm control by ZEITLUPE and the roles of phototropins and UVR8 in plant responses to light.

3.Students will explore light-hormone interactions in plant growth, development, and stress responses, focusing on phototropism and photomorphogenesis.

4.Students will gain knowledge of key experiments and concepts in photosynthesis, including photosystems, the Z-scheme, and various photosynthetic pathways.

UNIT-I

Characteristics of light, plant photoreceptors and its classification, phytochrome structure and action potential, phytochrome responses (VLFR, LFR, HIR), phytochrome signaling pathways (gene regulation by PIFs, COP regulation), blue light kinetics, cryptochrome structure and action potential, CRY-COP interaction.

UNIT-II

Control of circadian rhythm by ZEITLUPE, phototropins structure and action potential, role of phototropins in chloroplast movement and stomatal opening, UVR8 structure and action potential, responses to UV radiation and molecular mechanism of UVR8 function.

UNIT-III

Light-hormone interplay in phototropism, photomorphogenesis, chlorophyll biosynthesis, defense and development, molecular mechanism of shade avoidance, role of yellow and green light in growth, development, shade avoidance and stress responses, mechanisms of sensing and responding to light stress in plants.

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UNIT-IV

Key experiments in understanding photosynthesis, antenna system, photosystems, Z-scheme, repair and regulation of photosynthetic machinery, genetics, assemble and evolution of photosynthetic systems, C3 cycle, RuBisCO regulation, photorespiration, C4, CAM and SAM photosynthesis.

Part- D Recommended Books/e-resources/LMS:

1.Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2023). Plant physiology and development (7th ed.). Sinauer Associates.

2.Mohr, H., & Schopfer, P. (2020). Plant physiology (2nd ed.). Springer.

3.Kochhar, S. L., & Gujral, S. K. (2020). Plant physiology: Theory and applications (2nd ed.). Cambridge University Press.

4.Nobel, P. S. (2020). Physicochemical and Environmental Plant Physiology (5th ed.). Academic Press.

5.Pessarakli, M. (Ed.). (2024). Handbook of plant and crop physiology (4th ed.). CRC Press (Routledge).

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Phytochemistry and Pharmacognosy (26-BOT-407)

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: Phytochemistry and Pharmacognosy

Course Code: 26-BOT-407 Course Type: DEC-18

Course Credits: 04 Teaching Hours per week: 04

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

This course is designed to provide comprehensive knowledge of Phytochemistry and Pharmacognosy. The syllabus is structured according to the principles of the National Education Policy (NEP-2020) and aligned with contemporary patterns of UGC-NET/CSIR-NET Life Sciences examinations.

Course Outcomes (COs)

After completion of the course, students will be able to:

6. Understand protein and non-protein amino acids, protein structure and sequencing, special forms of DNA and RNA including isolation and purification techniques.
7. Know about carbohydrates including their classification, structure, properties, types and functions.
8. Understand the roles of water-soluble and fat-soluble vitamins.
9. Explore Pharmacognosy, the classification and evaluation of crude drugs, and the structure and classification of secondary metabolites.
10. Gain knowledge on source plants, parts used, and uses of various bio active compounds, along with commonly used extraction methods.

Part C- Instructions for Paper Setter:

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.

The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions in all selecting one question from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Protein and non-protein amino acids, Ramachandran plot, protein (levels of organization), protein sequencing and assays, protein isolation and purification. Special forms of DNA (triplex and G-quadruplex), DNA denaturation and quantification, supercoiling, DNA

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isolation and purification. RNA world hypothesis, RNA stability and thermodynamics, RNA isolation and purification.

UNIT-II

Carbohydrates (classification, structure and optical properties), reducing and non-reducing sugars, monosaccharide derivatives (sugar alcohols, sugar acids, glycosides and amino sugars), disaccharides (glycosidic bond with examples and sucrose hydrolysis), polysaccharides (homo and hetero), glycoproteins. Water soluble and fat soluble vitamins (biosynthetic precursors and roles).

UNIT-III

Pharmacognosy and its importance in modern medicine, crude drugs, classification of drugs (chemical and pharmacological), drug evaluation (organoleptic, microscopic, chemical, physical and biological), classification and structure of secondary metabolites (terpenes, phenolics and N-containing).

UNIT-IV

Source plant parts used and uses of solasodin, diosgenin, digitoxin, catechin, gingerol, curcuminoids, paclitaxel, quinine, atropine. pilocarpine, strychnine, reserpine, vinblastine. sennoside and capsaicin and the most commonly used methods of their extraction.

Part-D Recommended Books/e-resources/LMS:

1.Berg, J. M., Tymoczko, J. L., & Stryer, L. (2022). Biochemistry (10th ed.). W. H. Freeman.

2. Voet, D., Voet, J. G., & Pratt, C. W. (2020). Fundamentals of biochemistry: Life at the molecular level (6th ed.). Wiley.

3. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W. H. Freeman.

4. Evans, W. C. (2020). Trease and Evans' pharmacognosy (19th ed.). Elsevier.

5. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). Pharmacognosy (56th ed.). Nirali Prakashan.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Dissertation (26-BOT-Disser-400)

Maximum Marks: 200

External Evaluation: 100
Internal Assessment: 100

Part A – Introduction Programme and Course

Name of Programme: M.Sc. Botany

Name of the Course: **Dissertation**

Course Code : **26-BOT-Disser-400**

Course Type- Dissertation

Course Credits: 12

Part B-- Course Objectives and Course Learning Outcomes (CLOs):

Course Objectives

In this paper mentor will assign a minor research topic during IIIrd semester. The student shall work on the allotted topic under the guidance of mentor. The student has to give a pre-presentation on the allotted topic at the end of IIIrd semester (as mentioned in research training course of semester III) before the department research commiittee in the department. The dissertation work should be original work of the student and free from any sort of plagiarism.

Outcomes expected of Dissertation writing

The following **four** outcomes must be achieved during III Semester:

i. Research Problem identification

ii. Review of literature

iii. Research design formulation

iv. Commencement of experimentation, fieldwork, or similar tasks

Semester IV

The following **three** outcomes must be achieved by the mid of IV Semester:

1. Completion of experimentation/ fieldwork.
2. Submission of dissertation.
3. Research output shall be publication in a reputed peer reviewed/refereed Journal such as Scopus indexed/web of Science journals or other similar quality journal/ Book or Book chapter in a publication by a reputed publisher.

Dissertation/Project Work:

A student who opts for Dissertation/Project work of 12 credits in 4th / 2nd semester of 2-year / 1-year PG Programme will be required to do the research work based on systematic, scientific and rigorous investigations on the chosen and approved topic utilizing relevant research methods/techniques/innovations.

1. A student, who opts for Dissertation/Project work in 4th semester of 2year PG Programme, shall submit a request for allotment of a supervisor mentioning her/his research areas of

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interest in order of preference to the Chairperson/Principal/Director during 3rd semester. The Department/College/Institute will allot a qualified supervisor to guide the student for doing research for Dissertation/Project work. A full-time teacher/mentor of that Department/College/Institute, will be eligible to guide the students for Dissertation/Project work.

2. The student will submit the synopsis to the supervisor/mentor. In case of University Teaching Department (UTD), the synopsis will be approved by the Departmental Committee after recommendation of the supervisor.

3. In case of affiliated Colleges/Institutes, the Principal/Director shall constitute a committee of at least three members of the concerned subject for this purpose at the College/Institute level. The committee will consist of at least one subject expert from Chaudhary Bansi Lal University, Bhiwani to be nominated by the Chairperson/Director on the request of College/Institute. The request for external expert should reach to the Chairperson/Director before 30th November of the concerned year. The list of students, their approved topics, and names of supervisors along with their synopsis will have to be submitted by the College/Institute to the respective Chairperson/Director latest by 31st January of the concerned year.

4. The student shall be required to submit three hard copies of her/his dissertation or project report along with soft copy as PDF file to the Department/College/Institute by 31st May of the concerned year which will be forwarded to the Controller of Examinations for evaluation within a week.

5. The anti-plagiarism policy of the University will have to be strictly followed by the candidate and the supervisor for dissertation/project report. Similarity report certificate issued by the Librarian as per anti- plagiarism policy of the university is to be annexed with the dissertation/project report.

6. Evaluation of the dissertation/project report shall be done by an external examiner. The panel of examiners for evaluation of dissertations/project reports will be approved by the respective Board of Studies.

7. The schedule as specified above is to be strictly followed by the student and Department/College/Institute and any relaxation will not be allowed. However, in exceptional circumstances, late submission may be allowed with a late fee, as decided by the University authorities from time to time.

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