UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A ++' GRADE' UNIVERSITY)
Baba Sahib Ambedkar Road, Jammu-180006 (J&K)

Academic Section
Email: academicsectionju14@gmail.com

NOTIFICATION
(25/Aug/Adp./37)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the syllabi and courses of studies for **Post Graduate Programme in Botany** under **NEP-2020** as per details given below:-

Two Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Botany	Semester-I	December 2025, 2026 and 2027
	Semester-II	May 2026, 2027 and 2028
	Semester-III	December 2026, 2027 and 2028
	Semester-IV	May 2027, 2028 and 2029

One Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Botany	Semester-I	December 2026, 2027 and 2028
	Semester-II	May 2027, 2028 and 2029

The Syllabi of the courses are also available on the University website: www.jammuuniversity.ac.in

Sd/-
DEAN ACADEMIC AFFAIRS

No. F. Acd/II/25/6821-42
Dated: 21/8/25

Copy for information and necessary action to:

1. Dean, Faculty of **Life -Science**
2. Director/Convener, Board of Studies in **Botany**
3. Director, Centre for IT Enabled services and Management, University of Jammu for information and for uploading on University Website.
4. All members of the Board of Studies
5. Joint Registrar (Evaluation/P.G. Exam.)
6. Programmer, Computer Section, Examination Wing

20/8/25
Joint Registrar (Academic)

19/8/25 19/8/25

SYLLABI FRAMEWORK FOR PG PROGRAMME IN BOTANY (1 YEAR))

PG SYLABI 2025

S. No.	Course No.	Course Title	No. of Credits	Credits Level	Credit Points	Course Type Core/Elective /Any other	Marks Theory	Marks Practical	Nature of Course Global	Nature of Course National	Nature of Course Regional	Nature of Course Skill	SWAYAM/ MOOC	Vocational Course	Research Project/ Summer Internship/ Dissertation
1.	P1BOTC101	Physiology and Metabolism of Plants	4	6.5	26	Core	100	-	✓	✓	✓				
2.	P1BOTC102	Ecology and Conservation	4	6.5	26	Core	100	-	✓	✓	✓				
3.	P1BOTC103	Cell and Molecular Biology of Plants	4	6.5	26	Core	100	-	✓	✓	✓				
3.	P1BOTC104	Plant Breeding	2	6.5	13	Core	50	-	✓	✓	✓	✓			
4.	P1BOPC105	Practical course based on P1BOTC101 and P1BOTC102	2+2	6.5	26	Core	-	100	✓	✓	✓	✓			
5.	P1BOPC106	Practical course based on P1BOTC103 and P1BOTC104	2+2	6.5	26	Core	-	100	✓	✓	✓	✓			
6.	P1BOTE107	Plant -Based Indigenous Traditional Knowledge Systems in India	2	6.5	13	Elective	50	-	✓	✓	✓	✓			
7.	P1BOTE108	Fundamentals and Applications of Biomimetics	2	6.5	13	Elective	50	-	✓	✓	✓				
8.	P1BOTE109	Mushrooms: Diversity, Cultivation, and Applications	2	6.5	13	Elective	50	-	✓	✓	✓	✓			
9.	P1BOPE110	Practical course based on P1BOTE107	2	6.5	13	Elective	-	50	✓	✓	✓	✓			
10.	P1BOPE111	Practical course based on P1BOTE108	2	6.5	13	Elective	-	50	✓	✓	✓	✓			
11.	P1BOPE112	Practical course based on P1BOTE109	2	6.5	13	Elective	-	50	✓	✓	✓	✓			
13.	P1BOMO120	MOOC	4	6.5	26	MOOC	100	-	✓	✓	✓	-	✓		
14.	P1BOTC201	Genetic Engineering of Plant and Microbes	2	6.5	13	Core	50	-	✓	✓	✓	✓			
16.	P1BOTC202	Biostatistics	2	6.5	13	Core	50	-	✓	✓	✓	✓			
17.	P1BOTC203	Practical course based on P1BOTC201	2	6.5	13	Core	-	50	✓	✓	✓	✓			
18.	P1BOPC204	Practical course based on P1BOTC202	2	6.5	13	Core	-	50	✓	✓	✓	✓			
19.	P1BOTE205	Biodiversity Informatics	2	6.5	13	Elective			✓	✓	✓				
20.	P1BOTE206	Industrial Microbiology and Public Health	2	6.5	13	Elective	50	-	✓	✓	✓	✓			
21.	P1BOTE207	Plant Molecular Stress Physiology	2	6.5	13	Elective	50	-	✓	✓	✓				
22.	P1BOPE208	Practical course based on P1BOTE205	2	6.5	13	Elective	-	50	✓	✓	✓	✓			
23.	P1BOPE209	Practical course based on P1BOTE206	2	6.5	13	Elective	-	50	✓	✓	✓	✓			
24.	P1BOPE210	Practical course based on P1BOTE207	2	6.5	13	Elective	-	50	✓	✓	✓	✓			
25.	P1BORC211	Research Project	16	6.5	104	Core	-	400	-	-	-	✓			Research Project/Dissertation

*Over and above 4 credits to be earned through MOOCs

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COURSE STRUCTURE FOR ONE YEAR M. Sc. PROGRAM IN BOTANY (SEMESTER I & II)

Course Code	Course Title	Credits
Credit Framework for Semester-I		
Major Core [10 (T) + 6 (P)]		
P1BOTC101	Physiology and Metabolism of Plants	4
P1BOTC102	Ecology and Conservation	4
P1BOTC103	Cell and Molecular Biology of Plants	4
P1BOTC104	Plant Breeding	2
P1BOPC105	Practical course based on **P1BOTC101** and **P1BOTC102**	2+2
P1BOPC106	Practical course based on **P1BOTC103** and **P1BOTC104**	2+2
	Total Credits	**22**
Major Elective (any one) (2T+2P)		
P1BOTE107	Plant-Based Indigenous Traditional Knowledge Systems in India	2
P1BOTE108	Fundamentals and Applications of Biomimetics	2
P1BOTE109	Mushrooms: Diversity, Cultivation, and Applications	2
P1BOPE110	Practical course based on **P1BOTE107**	2
P1BOPE111	Practical course based on **P1BOTE108**	2
P1BOPE112	Practical course based on **P1BOTE109**	2
	Total Credits (Major Elective)	**4**
P1BOMO120	***MOOC**	**4**
	Total credits to be earned in Semester- I	**26 (22 Core + 4 Elective)**

Following is the breakup:
Total Credits to be earned in Semester I: 26
***Over and above 4 credits to be earned through MOOC**

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Course Code	Course Title	Credits
	Credit Framework for Semester-II	
	Major Core [10 (T)]	
P1BOTC201	Genetic Engineering of Plants and Microbes	2
P1BOTC202	Biostatistics	2
P1BOPC203	Practical course based on **P1BOTC201**	2
P1BOPC204	Practical course based on **P1BOTC202**	2
	Total Credits	**8**
	Major Elective (any one) (2T+2P)	
P1BOTE205	Biodiversity Informatics	2
P1BOTE206	Industrial Microbiology and Public Health	2
P1BOTE207	Plant Molecular Stress Physiology	2
P1BOPE208	Practical course based on **P1BOTE205**	2
P1BOPE209	Practical course based on **P1BOTE206**	2
P1BOPE210	Practical course based on **P1BOTE207**	2
	Total Credits (Major Elective)	**4 (2T+2L)**
P1BORC211	**Research Project**	**16**
	Total credits to be earned in Semester- II	**28 (8 Core + 4 Elective + 16 Research project)**

Following is the breakup:
Total Credits to be earned in Theory: 22;
Total Credits to be earned in Practical courses: 16;
Total Credits to be earned through Project work: 16;
Total Credits to be earned: 54
***Over and above 4 credits to be earned through MOOC in Semester I**

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Physiology and Metabolism of Plants

Course No.: P1BOTC101
Credits: 4
Duration: 3 hrs

Maximum Marks: 100
Test I: 20 Marks
Test II: 20 Marks
Major Test: 60 Marks

Course Objectives: *The course is designed to make students understand how different enzymes, molecular signals and hormones regulate important reactions and activities in plants. Another aim is to impart students' knowledge regarding the mechanisms underlying absorption of water and minerals, solute transport, photosynthesis, respiration, nitrogen and sulphur metabolism*

Course Outcomes: *The students will be able to:*

- *Understand the structure, classification, kinetics and regulation of plant enzymes, along with their role in photosynthesis, respiration and nitrogen metabolism.*
- *Explain the mechanisms of signal transduction and hormone signaling pathways, including the physiological roles of plant growth regulators and stress signals.*
- *Analyze the processes of water and mineral absorption, photochemistry, carbon assimilation and energy production in plants.*
- *Evaluate the importance of nitrogen and sulfur metabolism in plant nutrition, growth and environmental adaptation.*
- *Apply knowledge of emerging concepts like scotobiology, hydroponics and root-based climate resilience strategies in the context of sustainable agriculture.*

UNIT I: Enzymology and its role in life processes

1.1 Enzymes: International Union of Biochemists classification system, special reference to latest developments.

1.2 Enzyme structure analysis and predictions: databases of pre-computed models of key enzymes of photosynthesis, molecular docking for enzyme activity analysis.

1.3 Enzyme kinetics: Michaelis-Menton equation, line Weaver Burk plots, double reciprocal plots, ping pong mechanism with suitable examples.

1.4 Protein data banks: 2D and 3D structural and functional relation in enzymes, molecular factors regulating enzymes of CO_2 fixation and nitrogen metabolism.

UNIT II: Photobiology and signal transduction

2.1 Signal transduction: concept, receptors, G-proteins, phospholipid signaling, second messengers- a general account.

2.2 Diversity in protein kinases and phosphatases, calcium-calmodulin cascade, specific signaling mechanisms; two component sensor-regulator system in bacteria.

2.3 Plant roots and climate resilience: root modifications, their morphological and anatomical changes, impact on water and nutrient uptake. Root flexibility and its climate resilience in important cash crops (with suitable examples).

2.4 Scotobiology- overview, impact of darkness on plant growth and development, ecological responses of night pollution on plant habits.

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UNIT III: Plant hormone signaling and perception

3.1 Auxins, cytokinins, gibberellins and brassinosteroids – biosynthesis (overview) and signal transduction in plants.
3.2 Abscisic acid, ethylene, jasmonic acid, salicylic acid and strigolactones- biosynthesis (overview) and signal transduction in plants.
3.3 Hydroponics as a future of urban agriculture: types of hydroponics, methods and procedures with suitable examples (lettuce, bak-choi, red lettuce, exotic fruits etc.), developments of hydroponics to combat the climate crisis.
3.4 Hydrogen peroxide, hydrogen sulfide, reactive oxygen species and reactive nitrogen species interaction with plant hormones and role in stress management.

UNIT IV: Photochemistry and photosynthesis.

4.1 Evolution of photosynthetic apparatus, light harvesting complexes, photo-oxidation of water.
4.2 Mechanism of electron and proton transport, energy flow pathways, cyclic, non-cyclic and pseudo cyclic pathways.
4.3 Carbon assimilation-Calvin cycle, C4 cycle, difference between C3 and C4 pathways, CAM pathways, photorespiration and its significance.
4.4 Biosynthesis of starch and sucrose and their regulation.

UNIT V: Respiration, Nitrogen and Sulphur metabolism

5.1 Overview of plant respiration, glycolysis, TCA cycle.
5.2 Electron transport system and recent advances in mechanism of ATP synthesis.
5.3 Nitrogen fixation-overview, biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction; ammonium assimilation (GS/GOGAT cycle).
5.4 Sulphur metabolism- overview, sources and mechanism of sulphur uptake, transport, assimilation and its significance.

Suggested readings

- Bhatla, S. C. and Lal, M. A. (2018). Plant Physiology, development and metabolism Springer.
- Brown, T. A. (2017) Biochemistry. Viva Publishers.
- Buchanan, B. B., Gruissem, W. and Jones, R. L. (2015). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologist, Maryland, USA.
- Gardner, F. P., et al., (2013). Physiology of Crop Plants. Scientific Publishers, Jodhpur.
- Garrett, R. H. and Grisham, C. M. (2013). Biochemistry. 5th ed. Brooks/ Cole, Australia.
- Heldt, H-W. (2016). Plant Biochemistry. 4th ed. Academic Press, USA.
- Hopkins, G.W. and Hiinner, N. P. A. (2008). Introduction to Plant Physiology. 4th Edn. Wiley and Sons. Inc. New York, U.S.A.
- Nelson, D. L. and Cox, M. M. (2013). Lehninger-Principles of Biochemistry. Worth Publishers Inc. New York, USA.
- Nobel, P. S. (1999). Physio-chemical and Environmental Plant Physiology. 2nd Edn. Academic Press, San Diego, U.S.A.
- Prasad, M. N. V. (2014). Plant Ecophysiology. John Wiley, New York.
- Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. 4th Edn. Wadsworth Publishing Co., California, U.S.A.

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- Srivastava, L.M. (2002). Plant Growth and Development. Academic Press, USA.
- Taiz, L. and Zeiger, E. (2010). Introduction to Plant Physiology. 5th Edn. Sinauer Associates, Inc.
- Taiz, L. et al., (2018). Plant Physiology and Development. 6th ed. Oxford, New York.
- Voet, D., Voet, J. G. and Pratt. C. W. (2016). Voet's Principles of Biochemistry. 5th ed. John Wiley & Sons, Singapore.
- Willey, Neil. (2016). Environmental Plant Physiology. Garland Science, New York.

Note for Paper Setting

<table>
<tr><th>MCQ on LMS + Subjective Test</th><th>Syllabus to be covered in theExamination</th><th>Time allotted for the Exam</th><th colspan="2">% weightage (marks)</th></tr>
<tr><td>Test I (After 30 days)</td><td>Up to 20%</td><td>1 hour.</td><td colspan="2">10 +10</td></tr>
<tr><td>Test II (After 60 days)</td><td>21% to 40%</td><td>1 hour.</td><td colspan="2">10 +10</td></tr>
<tr><td>Theory</td><td>Syllabus to be covered in theExamination</td><td>Time allotted for the Exam</td><td colspan="2">% weightage (marks)</td></tr>
<tr><td>Major Test (After 90 days)</td><td>100%</td><td>3hours.</td><td colspan="2">60</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">100</td></tr>
<tr><td colspan="5">Practical/Research (Thesis/project/dissertation)</td></tr>
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<tr><td>Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)</td><td>4 hours</td><td colspan="3">25%</td></tr>
<tr><td rowspan="2">External Examination</td><td rowspan="2">4 hours</td><td rowspan="2">75%</td><td>50%</td><td>Final Practical Performance</td></tr>
<tr><td>25%</td><td>Viva-Voce</td></tr>
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</table>

Test I and Test II

The subjective test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re – appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 08 parts (minimum 01 from each unit) of 03 marks each. Section-B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). Students are required to attempt 01 question from each unit of section B. In major test there should not be a gap of more than two days in between two tests.

List of Practicals

- Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
- Determination of chlorophyll a and chlorophyll b and its ratio in C3 and C4 plants.
- Extraction of seed proteins depending upon the solubility.
- Determination of the respiratory quotient (RQ) for germinating seeds by Ganong's Respirometer.
- Preparation of the standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry's and Bradford's method.
- Extraction and qualitative estimation of amino acids from plant tissue by using paper chromatography.
- Extraction and qualitative estimation of sugars and organic acids by paper chromatography.
- Ascorbic acid extraction and quantitative estimation from plant tissues.
- Determination of effect of time and enzyme concentration on the rate of reaction of enzyme. eg. acid phosphatase, nitrate reductase, catalase.
- Determination of effect of substrate concentration of activity of an enzyme.
- Determination of the effect of anaesthetics, temperature and high pressure on the permeability of beet root tissue.
- Principles of colorimeter, spectrophotometer and fluorimeter.
- Study of degree of dissociation of an electrolyte by plasmolytic method.
- Determination of temperature coefficient (Q10) of water absorption by wheat seeds and potato tubers.

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PG SEMESTER–I
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Ecology and Conservation

Course No.: P1BOTC102
Credits: 4
Duration: 3 hrs

Maximum Marks: 100
Test I: 20 Marks
Test II: 20 Marks
Major Test: 60 Marks

Course Objectives: *The objective of this course is to provide postgraduate students with a comprehensive, interdisciplinary understanding of ecological systems and the science of biodiversity conservation. Students will gain theoretical knowledge and practical skills to analyze, interpret, and address complex ecological challenges facing natural ecosystems in a rapidly changing world. The course integrates advanced ecological principles, conservation theory, quantitative tools, and policy frameworks to foster critical thinking and problem-solving abilities in real-world environmental contexts.*

Course Outcomes: *After completing this course, students will be able to:*

- *Apply ecological theory to real-world biodiversity and conservation challenges*
- *Use statistical and computational tools to analyze ecological data*
- *Design conservation strategies informed by ethics, policy, and science*
- *Work across disciplines and scales, from local fieldwork to global conservation planning*

UNIT I: Ecological systems and processes

1.1 Foundations of modern ecology: historical development and paradigm shifts in ecology; ecosystem organization and hierarchy (individuals to biosphere).
1.2 Trophic dynamics and energy flow: primary production, trophic efficiency, food web theory; energetics in terrestrial and aquatic systems.
1.3 Biogeochemical cycles and ecosystem function: Carbon, Nitrogen, Phosphorus cycles and human disruption; stoichiometry and nutrient limitation.
1.4 Disturbance ecology and succession: natural vs. anthropogenic disturbances, community assembly, resilience, thresholds and ecological succession.

UNIT II: Population, community and landscape ecology

2.1 Population dynamics and life-history strategies: age-structured models (Leslie matrices), stochasticity, extinction risk, reproductive strategies and life history evolution.
2.2 Species interactions and community ecology: competitive exclusion, mutualism, facilitation, keystone species, guilds, trait-based community ecology.
2.3 Biodiversity patterns and metrics: alpha, beta, gamma and functional diversity.
2.4 Landscape ecology and spatial Processes: Patch dynamics, fragmentation, metapopulations, use of GIS/Remote sensing and landscape metrices.

UNIT III: Quantitative and computational ecology

3.1 Ecological statistics and modeling: hypothesis testing, regression, ANOVA; species distribution models (SDMs), occupancy models.
3.2 Programming in R and data analysis: biodiversity indices, ordination, clustering; time-series analysis and forecasting.
3.3 Remote sensing and GIS for ecological applications: land use/land cover change detection; habitat suitability analysis.

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3.4 Citizen science and big data in ecology: iNaturalist, GBIF, eBird, camera traps, acoustic sensors; data quality and bias in ecological datasets.

UNIT IV: Conservation biology– science and practice

4.1 Principles of conservation biology: Small population paradigm, minimum viable population; conservation genetics, evolutionary potential.
4.2 Threats to biodiversity: overexploitation, invasive species, habitat loss, climate change; extinction debt and anthropocene extinction.
4.3 Conservation strategies and protected area design: In-situ (national parks, biosphere reserves); ex-situ (seed banks, cryopreservation), conservation prioritization tools (Zonation, Marxan).
4.4 Species and ecosystem recovery programs: flagship and umbrella species approaches; success stories and challenges (global case studies).

UNIT V: Conservation policy, ethics and emerging frontiers

5.1 Conservation policy and international treaties: CBD, UNFCCC, Ramsar, CITES, IPBES; environmental law and governance.
5.2 Environmental ethics and justice: deep ecology, biocentrism, rights of nature; conservation and human rights, equity, and inclusion.
5.3 Indigenous and local knowledge (ILK): traditional ecological knowledge (TEK), biocultural diversity; community-led conservation and participatory approaches
5.4 Future of conservation: innovations and challenges: eDNA, AI, drones, satellite monitoring; rewilding, assisted migration, synthetic biology in conservation

Suggested readings

- Groom, M. J., Meffe, G. K. and Carroll, C. R. (2020). Principles of Conservation Biology (4th Edition) Sinauer Associates (an imprint of Oxford University Press).
- Hone, J. (2022). Applied Population and Community Ecology: The Case of Patchy Populations (2nd Edition) Oxford University Press.
- Hunter Jr, M. L. and Gibbs, J. P. (2006). Fundamentals of conservation biology. John Wiley & Sons.
- Jeffries, M. J. (2022) Biodiversity and Conservation (3rd Edition) Routledge (Taylor & Francis Group).
- Kareiva, P. and Marvier, M. (2021) Conservation science: Balancing the needs of people and nature (3rd ed.). Macmillan Learning.
- Robert, E. R. and Rick, R. (2021) Ecology: The Economy of Nature (9th Edition) W. H. Freeman / Macmillan Learning.
- Sodhi, N. S. and Ehrlich, P. R. (Eds.). (2010). Conservation Biology for All. Oxford University Press.
- Townsend, C., R., Begon, M. and Harper, J. L. (2021). Essentials of Ecology (5th Edition) Wiley-Blackwell.
- Vellend, M. (2016). The Theory of Ecological Communities (1st Edition) Princeton University Press.
- Wegmann, M., Leutner, B. and Dech, S. (2020). Remote Sensing and GIS for Ecologists: Using Open-Source Software (2nd Edition) Pelagic Publishing.

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- Wickham, H. and Grolemund, G. (2017). R for data science: Import, tidy, transform, visualize, and model data. O'Reilly Media.

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Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 08 parts (minimum 01 from each unit) of 03 marks each. Section-B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- Field identification of flora and fauna.

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- Quadrat and transect sampling, biodiversity surveys.
- NDVI and habitat mapping using Google Earth Engine.
- Analysis of biodiversity datasets in R.
- Field-based mini-projects on conservation assessment.
- Physico-chemical analysis of water samples.
- Productivity studies of terrestrial and aquatic ecosystems.
- Change detection using the temporal satellite scenes.

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Cell and Molecular Biology of Plants

Course No.: P1BOTC103
Credits: 4
Duration: 3 hrs

Maximum Marks: 100
Test I: 20 Marks
Test II: 20 Marks
Major Test: 60 Marks

Course Objectives: *The present course envisages making the students aware of the nature and scope of plant life at the cellular and molecular levels including those of other pro- and eukaryotes.*

Course Outcomes:

- *The students will gain knowledge and updated information on the structural and functional aspects of cell and its related organelles at micro- and macro-molecular levels as well as the fine structure of gene and gene expression in pro- and eukaryotes.*
- *They will be able to carry out any study related to analyzing life at sub-cellular or molecular level.*

UNIT I: Cell and its envelopes

1.1 Diversity of cell and its evolution: cell wall-physical diversity in various life forms; details of structure and biogenesis of cell wall in plants.

1.2 Structure of model membranes in pro- and eu-karyotes; evolution of fluid- mosaic model of plasma membrane; details of lipid bilayer and membrane proteins in terms of structural diversity; concept of lipid rafts, asymmetrical and artificial membranes.

1.3 Transport across membrane-passive (simple and facilitated) and active transport; details of membrane channels, pumps and carriers.

1.4 Electric properties of membranes-Neurotransmission and its regulation; concept of action potential; neurotransmitters and neuroreceptors (GABA and NMDA).

UNIT II: Cellular communication, cytoskeleton and internal compartments

2.1 Cell adhesion and role of different adhesion molecules; structure and functions of plasmodesmata and gap junctions.

2.2 Structure and organization of microfilaments and microtubules; their role in intracellular motility with emphasis on vesicular traffic and chromosome movement during cell division

2.3 Structural organization, biogenesis and an overview of functions of plant cell specific organelles (vacuole, plastids and peroxisomes).

2.4 Structural organization and overview of functions of mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus, lysosomes and melanosomes.

UNIT III: Nuclear contents-structure, synthesis and functions

3.1 Nucleus: structure, molecular organization and function of nuclear envelope, nuclear pore complex and transport; ultra structure of nucleolus; nuclear bodies

3.2 DNA: structure and geometry of A, B and Z forms; single stranded DNA; topology and super coiling of DNA; organelle genomes.

3.3 DNA replication: enzymology; mechanism in pro- and eukaryotes; rolling circle replication.

3.4 Transcription: machinery, mechanism and regulation; plant promoters and transcription factors.

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UNIT IV: RNA and Proteins-structure, synthesis and function

4.1 RNA types: mRNA, tRNA and rRNA; overview of their structure and biosynthesis; formation and significance of micro-RNAs and non-coding RNAs.
4.2 Introns: types and their significance; mechanisms of RNA splicing; mRNA processing and transport.
4.3 Genetic code: nature, degeneracy, universality, Wobble hypothesis; Translation: ribosomes; mechanism in pro- and eukaryotes; factors involved thereof.
4.4 Protein structure and trafficking: protein structure and modification; concept and role of chaperones, co-translation and post-translation transport.

UNIT V: Cell cycle and cell death

5.1 Cell cycle: control mechanism; role of cyclins and cyclin dependent kinases, and CAKs, CKIs and CIPs; checkpoints in cell cycle regulation; ATM/ATR surveillance operators.
5.2 Cancers: concept of hereditary and non-hereditary cancers; role of p53, Rb and E2F proteins; oncogenes and cancer suppressor genes.
5.3 Cell division: dynamics of cytokinesis and cell plate formation.
5.4 Cell death: types, importance, programmed cell death in the life cycle of plants

Suggested readings

- Alberts, et al., (2015). Molecular biology of the cell. 6th ed. Garland Science, New York.
- Brown, T. A. (1989). Genetics: A molecular Approach. VNR International
- Brown, T. A. (2010). Gene cloning and DNA Analysis- An introduction. 6th Edn. Wiley Blackwell.
- Brown, T. A. (2010). Genomes. John Wiley and Sons (Asia) Pvt. Ltd.
- Cooper, G. M. and Hausman, R. E. (2018). The Cell: A molecular approach. 7th ed. Sinauer Association, USA.
- De, D. N. (2000). Plant Cell Vacuoles: An introduction. CSIRO Publication, Colling wood, Australia.
- Freifelder, D. and Malacinski (1993). Essentials of Molecular Biology. Jones and Bartlett Publishers.
- Gardner, E. J., Simmons, M. J. and Snustad, D. (1991). Principles of Genetics. 8th Edn. John Wiley.
- Gupta, P. K. (1997). Elements of Biotechnology. Rastogi Publications, Meerut.
- Gupta, P. K. (2002). Cell and Molecular Biology. Rastogi Publications, Meerut.
- Hardin, Jeff. (2012). Becker's world of the cell. 8th ed. Pearson, Harlow.
- Hartl, D. L. and Jones, E. W. (2000). Genetics – An Analysis of Genes and Genomes. Jones and Bartlett Publishers.
- Helms, V. (2019). Principles of Computational Cell Biology. 2nd ed. Wiley, Germany.
- Iwasa, J. and Marshall, W. (2016). Karp's Cell and Molecular Biology-Concepts and Experiments. 8th ed. Wiley Plus, Singapore
- Jones, R., et al., (2017). Molecular Life of Plants. Wiley Blackwell.
- Karp, G. (1999). Cell and Molecular Biology – Concepts and Experiments. John Wiley and Sons Inc.
- Kleinsmith, L. J and Kish, V. M. (1995). Principles of Cell and Molecular Biology. Harper Collins College Publishers, NY.

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- Krishna Murthy, K.V. (2000). Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
- Lewin, B. (2000). Genes VII. Oxford University Press. N.Y.
- Lodish., et al. (2016). Molecular Cell Biology. 8th ed. Macmillan, New York.
- Old, R.W. and Primrose, S. B. (1994). Principles of Gene Manipulation. Blackwell Scientific Publication, London.
- Pollard, T. D., et al., (2017). Cell Biology. 3rd ed. Elsevier, USA.
- Russel, P. J. (1998). Genetics. Benjamin/Cummings Publishing Co. Inc.
- Sadava, D. E. (1992). Cell Biology – Organelle Structure and Function. Jones & Bartlett Publishers.
- Snustad, D. P. and Simmons, M. J. (2000). Principles of Genetics. John Wiley and Sons, NY.
- Stansfield, W. D. (1991). Genetics (Schaums outlines). McGraw Hill.
- Watson, J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. and Weiner, A. M. L. (1987). Molecular Biology of the Gene. The Benjamin/Cummings Publishing Company Inc.
- Wolfe, S. L. (1993) Molecular and Cellular Biology. Wadsworth Publishing Co. Calfornia, USA.

Note for Paper Setting

<table>
<tr><th>MCQ on LMS + Subjective Test</th><th>Syllabus to be covered in theExamination</th><th>Time allotted for the Exam</th><th colspan="2">% weightage (marks)</th></tr>
<tr><td>Test I (After 30 days)</td><td>Up to 20%</td><td>1 hour.</td><td colspan="2">10 +10</td></tr>
<tr><td>Test II (After 60 days)</td><td>21% to 40%</td><td>1 hour.</td><td colspan="2">10 +10</td></tr>
<tr><td>Theory</td><td>Syllabus to be covered in theExamination</td><td>Time allotted for the Exam</td><td colspan="2">% weightage (marks)</td></tr>
<tr><td>Major Test (After 90 days)</td><td>100%</td><td>3hours.</td><td colspan="2">60</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">100</td></tr>
<tr><td colspan="5">Practical/Research (Thesis/project/dissertation)</td></tr>
<tr><td>MCQ on LMS + Subjective Test</td><td>Time allotted for the Examination</td><td colspan="3">% weightage(marks)</td></tr>
<tr><td>Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)</td><td>4 hours</td><td colspan="3">25%</td></tr>
<tr><td rowspan="2">External Examination</td><td rowspan="2">4 hours</td><td rowspan="2">75%</td><td>50%</td><td>Final Practical Performance</td></tr>
<tr><td>25%</td><td>Viva-Voce</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">100</td></tr>
</table>

Test I and Test II

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The subjective test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re – appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 08 parts (minimum 01 from each unit) of 03 marks each. Section-B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). Students are required to attempt 01 question from each unit of section-B. In major test there should not be a gap of more than two days in between two tests.

List of Practicals

- Demonstration of SEM using an appropriate plant material and detailed study of electron micrograph of the plant cell thus taken to see the distribution of cell organelles.
- Isolation of chloroplasts and SDS-PAGE profiles of proteins to demarcate the two subunits of Rubisco.
- Fluorescence staining with FDA for cell viability and cell wall staining with calcoflour.
- Work out various problems associated with DNA replication process from the given data.
- Calculation of replication rates from the provided data.
- Preparation of agarose gel.
- Isolation of plasmid DNA from an appropriate host by alkali lysis method.
- Study the effect of some restriction enzymes on DNA.
- Estimation of the molecular weight of different DNA fragments.
- Work out the biochemical pathways operative in Neurospora on the basis of experimental data.
- Study the genic and extragenic inheritance patterns.
- Work out the gene maps using data from crosses, ordered and unordered tetrads.
- Detection of structural changes in the chromosomes using FISH technique.
- Bring out the phylogenetic relation between different taxa (varieties, species, genera) on the basis of enzyme profiles.
- Work out inter-specific variation using zymograms and mt DNA-RFLP.
- Isolation of DNA and its quantification by spectrophotometric method.
- Isolation of DNA and preparation of 'Cot' curve.
- Northern and southern blot analysis using a gene specific probe.

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Plant-based Indigenous Traditional Knowledge Systems in India

Course No.: P1BOTE107
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *The course aims to introduce students to the plant-based Indigenous Traditional Knowledge (ITK) systems of Indian origin. It focuses on understanding ethnobotanical practices, their cultural and ecological relevance, and methods of documentation and validation. Students will also learn about ethnobotanical indices, ethical issues, and legal frameworks related to traditional knowledge. The course encourages integration of traditional wisdom with scientific approaches for sustainable development.*

Course Outcomes: *After completing this course, students will be able to:*

- *Explain the principles, scope, and cultural context of plant-based Indigenous Traditional Knowledge systems in India.*
- *Identify and document traditional uses of plants through ethnobotanical field methods and participatory approaches.*
- *Apply ethnobotanical indices and quantitative tools to analyze traditional knowledge data.*
- *Critically evaluate the relevance of ITKs in biodiversity conservation, healthcare, and sustainable livelihoods.*
- *Understand the ethical, legal, and policy frameworks governing traditional knowledge.*

UNIT I: Foundations of plant-based ITK in Indian context

1.1 Conceptual framework: definition, characteristics, and typologies of indigenous traditional knowledge, theoretical frameworks of ITK.
1.2 Historical evolution: historical evolution of plant-based knowledge in India (Rigvedic references, Ayurveda, Siddha, Unani).
1.3 Knowledge holders: vaidyas, siddhas, hakims, tribal elders, folk practitioners-comparison and practices.
1.4 Knowledge transmission: modes of transmission (oral, apprenticeship, palm-leaf manuscripts, modern documentation).

UNIT II: Advanced applications of plant-based ITK

2.1 Healthcare systems: ethnopharmacology, polyherbalism and synergistic formulations, disease-specific plant remedies (malaria, skin disorders, diabetes).
2.2 Cultural and religious dimensions: ritual plants, totem species, sacred groves, seasonal calendars (phenology).
2.3 Ethnocosmology and plant symbolism: cosmologies and symbolism associated with plant use.
2.4 Modern interface: integrative health (AYUSH), agroecology, community biodiversity registers

UNIT III: Documentation and research methods

3.1 Methodologies for ITK documentation: field techniques: participant observation, freelisting, questionnaires and interviews (structured, semi structured and unstructured).

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3.2 Participatory approaches and ethics: PRA (Participatory Rural Appraisal), focus groups; taxonomic validation and herbarium development; ethics of working with knowledge holders (prior informed consent) and benefit sharing.

3.3 Bridging qualitative data and quantitative validation: Use Value (UV), Fidelity Level (FL), Informant Consensus Factor (ICF), Cultural Importance Index (CI) and Relative Frequency of Citation (RFC).

3.4 Scientific and interdisciplinary validation: phytochemical screening and bioactivity assays, cross-disciplinary linkages (Ethnobotany, Anthropology, Pharmacognosy); integrating ITK with AI/ML for big data ethnobotany.

Suggested readings

- Alexiades, M.N. (1996). Selected Guidelines for Ethnobotanical Research: A Field Manual. The New York Botanical Garden.
- Berkes, F. (2012). Sacred Ecology (3rd Edition). Routledge.
- Jain, S.K. (Ed.) (2000). Manual of Ethnobotany (2nd Edition). Scientific Publishers.
- Narayanan, M.K.R. (2017). Indigenous Knowledge Systems in India. Rawat Publications.
- National Biodiversity Authority (2002). Biological Diversity Act and Rules. Government of India.
- Posey, D.A. (Ed.) (1999). Cultural and Spiritual Values of Biodiversity. United Nations Environment Programme (UNEP).
- Pushpangadan, P., George, V. & Kumar, B. (2007). Ethnomedicine and Ethnopharmacology: Traditional Medicine and Modern Drug Discovery. New India Publishing Agency.
- Rout, S.D. & Panda, T. (2019). Ethnobotany: A Practical Approach. New India Publishing Agency.
- Singh, K.K. & Kumar, A. (2000). Indian Folk Medicines and Other Plant-Based Products. Scientific Publishers.
- World Health Organization (2002). WHO Traditional Medicine Strategy 2002–2005. World Health Organization Publications.

Note for Paper Setting

MCQ on LMS + Subjective Test	**Syllabus to be covered in the Examination**	**Time allotted for the Exam**	**% weightage(marks)**
Test I (After 30 days)	Up to 20%	30 min	5 +5
Test II (After 60 days)	21% to 40%	30 min	5 +5
Theory	**Syllabus to be covered in the Examination**	**Time allotted for the Exam**	**% weightage(marks**
Major Test (After 90 days)	100%	2 hours	30
Total			**50**
Practical/Research (Thesis/project/dissertation)			
MCQ on LMS + Subjective Test	**Time allotted for the Examination**	**% weightage(marks)**	
Mid Term Appraisal	4 hours	25%	

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(Evaluation of daily practical performance/ Practical Assignment/ Field Study)				
External Examination	4 hours	75%	50%	Final Practical Performance
			25%	Viva-Voce
Total			**50**	

Test I and Test II

The subjective test of Test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 03 parts (minimum 01 from each unit) of 02 marks each. Section-B will have 04 questions of 12 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- To collect data through various Ethnobotanical Interview Techniques.
- To Prepare of Herbarium Specimens with Traditional Use Data.
- To analyse qualitative data using various Ethnobotanical Indices.
- Comparative Analysis of Classical Texts and Local Knowledge.
- To document ITK through Digital tools.
- Pharmacognostic studies of medicinal plants.

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Plant Breeding

Course No.: P1BOTC104
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *Knowledge of genetic basis and techniques of various plant breeding methods is a must for evolving new varieties and improved crops to meet the ever-increasing demand of food in a progressing country like India. Understanding developed by the students on these aspects will be of great practical application and will help them to appreciate the importance of conventional plant breeding in context of advancements in the field.*

Course Outcomes:

- *This course will help the students to appreciate difference in approaches for genetic amelioration of crops with diverse breeding strategies.*
- *They would also appreciate the role novel genetic interventions in augmenting the achievements of conventional breeding.*

UNIT I: Genetic basis of plant breeding and population improvement

1.1 Introduction-aims and scope of plant breeding; methods of crop improvement, their correlation with reproductive modes operative in a species; concept of homozygous and heterozygous balance; Frequencies of genes and genotypes- Hardy-Weinberg equilibrium and its deviations.

1.2 Genetic basis of breeding self and cross-pollinated crops: pure line theory, hybrid vigour and inbreeding depression; genetic and physiological basis of heterosis, various theories. Role of microRNAs and gene interactions in heterosis.

1.3 Self-incompatibility, male sterility and apomixis in crop plants: details and their implications for hybrid production and fixation of heterosis.

1.4 Pure line and mass selection methods for self-pollinated crops. Mass selection and ear-to-row methods in cross-pollinated taxa. Clonal selection for vegetatively propagating taxa.

UNIT II: Hybridization for crop improvement

2.1 Population breeding in self-pollinated crops with special reference to Transgressive breeding. Pedigree, bulk and backcross methods: details, benefits and limitations.

2.2 Hybrid breeding in cross-pollinated crops: production of inbred, recurrent selection and its types. Details of differences in production of hybrid, synthetic and composite varieties, comparative benefits and drawbacks.

2.3 Clonal hybridization- details, possibilities and benefits.

2.4 Distant hybridization-concept and techniques, barriers to production of distant hybrids, applications in crop improvement with specific examples.

UNIT III: Special breeding techniques

3.1 Special breeding techniques: concept and achievements of mutation breeding, polyploidy breeding and double haploidy.

3.2 Prebreeding: concept and process. Strategies of prebreeding- convergent breeding, bridge crosses and interspecific hybridization.

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3.3 Ideotype breeding: steps involved, advantages, genome editing as a tool to achieve plant ideotype, advantages for making stress resilient crops.
3.4 Cultivar development: testing, release and notification, maintenance and participatory breeding.

Suggested readings

- Acquaah, G. (2020). Principles of Plant Genetics and Breeding, Wiley-Blackwell, USA
- Allard, R. W. (2018). Principles of plant breeding. 2nd ed. Wiley, New Delhi.
- Atwell, B. J., Kriedemann, P. E. and Turnbull, C. G. N. (1999). Plants in action: adaptation in nature, performance in cultivation. McMillan Education, Australia.
- Ayiecho, P. O. and Nyabundi, J. O. (2025) Conventional and contemporary practices of plant breeding. Springer
- Brown, J., Caligeri, P. and Compos, H. (2014). Plant Breeding. 2nd ed. Wiley Blackwell, U. K. 14.
- Sharma, J. R. (1994) Principles and practice of Plant Breeding. Tat-McGraw Hill Publishers.
- Sharma, J. R. (1998) Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers.
- Singh, B. D. (2022) Plant Breeding; principles and methods, Med Tech Science press, India.

Note for Paper Setting

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Test I (After 30 days)	Up to 20%	30 min	5 +5
Test II (After 60 days)	21% to 40%	30 min	5 +5
Theory	**Syllabus to be covered in theExamination**	**Time allotted for the Exam**	**% weightage(marks)**
Major Test (After 90 days)	100%	2 hours	30
Total			**50**

Practical/Research (Thesis/project/dissertation)				
MCQ on LMS + Subjective Test	**Time allotted for the Examination**	**% weightage(marks)**		
Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)	4 hours	25%		
External Examination	4 hours	75%	50%	Final Practical Performance
			25%	Viva-Voce
Total			**50**	

Test I and Test II

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The subjective test of Test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 03 parts (minimum 01 from each unit) of 02 marks each. Section-B will have 04 questions of 12 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- Study of natural modes of vegetative propagation using appropriate methods (bulb, corm, tuber, runner and sucker).
- Attempting different types of grafts using proper stock and scion.
- Demonstrating various types of layering.
- Studying the floral characters, pollen-ovule ratio and pollen stigma interactions in any self-pollinated crop preferably legumes.
- Studying various contrivances for out-crossing in common cross-pollinated crops available in the season (maize, bajra, jowar, trifoliums).
- Demonstrating various steps involved in carrying out hand/manual pollinations

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Fundamentals and Applications of Biomimetics

Course No.: P1BOTE108
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *Biomimetics is the scientific method of learning new principles and processes based on systematic study, observation and experimentation with plants, animals, micro-organisms, and ecosystems. Biomimicry is a field of design that uses engineering, architecture, and design techniques to address man-made challenges while attempting to find sustainable solutions by mimicking nature's tried-and-true patterns. Plants, animals, and microorganisms are the ultimate engineers and designers. They have discovered what functions, what is suitable, and—above all—what endures in this world. Following connects with the nature, education, and innovation, biomimicry represents a transformative approach to design and problem-solving, offering a pathway to more sustainable and efficient products and infrastructure. Its growing popularity and the increasing availability of resources and educational opportunities signal a promising future for this field.*

Course Outcomes: *To expose the students' minds to nature's solutions in terms of innovation, adaptation and evolution.*

- *Introduce and explain the basic concepts of biomimicry and/or bioinspiration.*
- *Stimulate creativity and the use of non-obvious solutions in Bioinspired design (BID) and processes.*
- *Enhance the students' critical thinking and problem-solving skills.*
- *Demonstrate the advantages of learning from nature to design new materials with enhanced structural and (multi)functional properties.*
- *Revise basic concepts related to materials science (supramolecular chemistry, surface physics, mechanical properties, soft matter, etc.) using natural systems as case studies*

UNIT I: Introduction to biomimicry

1.1 Concept of biomimicry, the nine laws of nature, doctrine of signature, the three levels of inspiration of biomimicry.
1.2 Functional morphology of plants – a key to biomimetic applications; morphology, anatomy and biomechanics of the respective plant or plant part.
1.3 Bioinspiration; nature inspired circular economy, self-repairing materials inspired by nature, efficient water and material mixing systems.
1.4 Plants as idea providers or concept generators, resurrection plants.

UNIT II: Nature, architecture and design

2.1 Bioinspiration in design and architecture: termite mounds (temperature control), honeybee hives. Giant lily and load-bearing platforms in architecture.
2.2 Shotgun fungus, bombardier beetles and spray technology.
2.3 Biomineralization, nacre: a strong material, source of inspiration for new materials (from mollusk shells, sponge spicules, etc.).
2.4 Learning from chromosomes; inventions and discoveries based on chromosomes.

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UNIT III: Biomimetics and sustainable development goals

3.1 Biomimicry for society and sustainability; biomimetic innovations for health, partnership, and life on land.

3.2 Plant- based light harvesting complexes- inspired solar panel design; artificial photosynthesis, Forest-inspired, myco-based nutrient cycling to break down toxic petrochemicals and construction debris.

3.3 Water harvesting by desert plants and animals: lessons from nature: an overview of desert plants and water harvesting mechanisms.

3.4 An overview of desert animals and water harvesting mechanisms; energy-efficient designs (use of cool materials and windbreaks).

Suggested readings

- Benyus, J. M. (2002) Biomimicry: Inventions Inspired by Nature. William Morrow & Company, pp. 320
- Gurera, D. and Bhushan, B. (2020) Passive water harvesting by desert plants and animals: lessons from nature. Phil. Trans. R. Soc. A 378: 20190444.
- https://www.learnbiomimicry.com/
- Lecointre, G., Aish, A., Améziane, N., Chekchak, T., Goupil, C., Grandcolas, P., et al., (2023) Revisiting nature's "unifying patterns": A biological appraisal. Biomimetics 8(4): 362.
- MacKinnon, R. B., Oomen, J. and Pedersen, Z., M. (2020) Promises and presuppositions of biomimicry. Biomimetics 5(3): 33.
- Raman, R., Sreenivasan, A., Suresh, M. and Nedungadi, P. (2024) Mapping biomimicry research to sustainable development goals. Scientific Reports 14(1): 18613.
- Slosar, N. (2021) Avians to Airplanes: Biomimicry in Flight and Wing Design. Berkeley Scientific Journal, Springer.

Note for Paper Setting

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Test I (After 30 days)	Up to 20%	30 min	5 +5
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Theory	**Syllabus to be covered in theExamination**	**Time allotted for the Exam**	**% weightage(marks)**
Major Test (After 90 days)	100%	2 hours	30
Total			**50**
Practical/Research (Thesis/project/dissertation)			
MCQ on LMS + Subjective Test	**Time allotted for the Examination**	**% weightage(marks)**	
Mid Term Appraisal (Evaluation of daily practical performance/	4 hours	25%	

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Practical Assignment/ Field Study)				
External Examination	4 hours	75%	50%	Final Practical Performance
			25%	Viva-Voce
Total			**50**	

Test I and Test II

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Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 03 parts (minimum 01 from each unit) of 02 marks each. Section-B will have 04 questions of 12 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- To study floral morphology and symmetry in different plant species and explore their relevance in biomimetic design (e.g., radial symmetry in engineering, pollination mechanisms).
- Analyze termite mound structures and their role in passive cooling.
- To examine leaf anatomy (arrangement, venation, cuticle) and understand their role in optimizing light absorption for solar panel design inspiration.
- Observation of adaptations (such as waxy coating, sunken stomata, and spines, and relate them to water conservation technologies) in desert plant (e.g., *Opuntia, Agave, Aloe vera* etc.).
- To observe spore discharge in macrofungi (application in spray or propulsion technologies).
- Field visit to a biomimetic innovation centre, botanical garden, or bioinspired architecture.
- Design a bioinspired model/system for sustainability (e.g., biodegradable packaging, plant-inspired shade structures).

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Genetic Engineering of Plants and Microbes

Course No.: P1BOTC201
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *Genetic Engineering is one of the most important fields of genetic research. Making students knowledgeable about the methods involved in modifying and manipulating genes within and between species, creating new medicines, producing disease resistant plants and diagnosing human diseases is the main aim of this course*

Course Outcomes:

- *Making students knowledgeable about the methods involved in modifying and manipulating genes within and between species,*
- *Familiarizing them with the methods employed for creating new medicines, producing disease resistant plants and diagnosing human diseases.*

UNIT I: Recombinant DNA technology

1.1 Principles and techniques of gene cloning; use of vectors (plasmids, phage, phagemids, cosmids, and artificial chromosomes- BAC, YAC, PAC and MAC) and enzymes therein.
1.2 Genomic and cDNA libraries – construction, different methods of screening and choice of vectors.
1.3 DNA isolation and amplification; Polymerase Chain Reaction and its variations (RT-PCR, Real-time –PCR).
1.4 DNA sequencing techniques- Sanger's sequencing method and Next-Generation sequence technologies (Pyro- and Illumina based sequencing); DNA fingerprinting techniques and application.

UNIT II: Genetic improvement of plants and microbes

2.1 Aims and strategies for development of transgenic plants. Transgenic plants for modified nutritional content, herbicide tolerance, insecticidal and viral resistance and delayed ripening; molecular pharming.
2.2 Agrobacterium-mediated gene transfer; binary vector and co-integration vector strategy; direct gene transfer methods: anti-sense RNA technology and gene knockout.
2.3 Genetic improvement technique of microbes for production of antibodies, polymers, bioplastics and edible vaccines.
2.4 Intellectual property rights with reference to genetically engineered organisms; GM crops in India (Bt Brinjal and Bt Mustard); issues and concerns.

UNIT III: Genomics, Proteomics and Bioinformatics

3.1 Physical mapping of genes, DNA markers (RFLP, RAPD, AFLP, SSLPs, SNPs).
3.2 Human genome project–aims, objectives, achievements and risks, technologies used; genome editing through ZFN, TALEN and CRISPR/Cas systems.
3.3 Introduction to proteomics and transcriptomics, techniques (Microarray) and applications.
3.4 Basic bioinformatics tools- NCBI, BLAST, ORF finder; genome annotation, sequence alignment.

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Suggested readings

- Bhat, T.A. and Al-Khayri, J. M. (Eds.). (2023). Genetic Engineering: Volume 1: Principles Mechanism, and Expression (1st ed.). Apple Academic Press.
- Brown, T. A. (1998). Genetics: A Molecular Approach. Chapman and Hall, London.
- Brown, T. A. (2010). Gene cloning and DNA Analysis- An introduction. 6th Edn. Wiley Blackwell.
- Brown, T. A. (2016). Gene Cloning and DNA Analysis: An Introduction (7th ed.). Wiley-Blackwell, UK.
- Brown, T. A. (2018). Genomes 4. Garland Science, New York.
- Brown, T.A. (2010). Genomes. John Wiley and Sons Pvt. Ltd., Singapore.
- Chrispeels, M. J. and Sadava, D. E. (1994). Plants, Genes and Agriculture. Jones & Bartlett Publishers, Boston, USA.
- Das, H. K. (2007). A Textbook of Biotechnology. 3rd Edn. Wiley India Pvt. Ltd. U.P., India.
- Daugherty, E. (2017). Biotechnology: Science for the New Millennium, EMC Paradigm, US.
- Glezer, A. N. and Nikaido, H. (1995). Microbial Biotechnology. W.H. Freeman and Company, New York, USA.
- Glick, B. R., Pasternak J. J. and Patten, C.L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edn. A.S.M. Press, Washington, DC.
- Henry, R. J. (1997). Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
- Jolles, O. and Jornvall, H. (2000). Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
- Nicholl, D. S. T. (2023). An Introduction to Genetic Engineering (4th ed.). Cambridge: Cambridge University Press.
- Primose, S. B. and Twyman, R. M. (2014). Principles of Gene Manipulation and Genomics. 7th ed. Wiley Blackwell, New Delhi.
- Primrose, S. B. (1995). Principles of Genome Analysis. Blackwell Science Ltd., Oxford, UK.
- Raghavan, V. (1997). Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.

Note for Paper Setting

MCQ on LMS + Subjective Test	**Syllabus to be covered in theExamination**	**Time allotted for the Exam**	**% weightage(marks)**
Test I (After 30 days)	Up to 20%	30 min	5 +5
Test II (After 60 days)	21% to 40%	30 min	5 +5
Theory	**Syllabus to be covered in theExamination**	**Time allotted for the Exam**	**% weightage(marks)**
Major Test (After 90 days)	100%	2 hours	30
Total			**50**
Practical/Research (Thesis/project/dissertation)			

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<table>
<tr><th>MCQ on LMS + Subjective Test</th><th>Time allotted for the Examination</th><th colspan="3">% weightage(marks)</th></tr>
<tr><td>Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)</td><td>4 hours</td><td colspan="3">25%</td></tr>
<tr><td rowspan="2">External Examination</td><td rowspan="2">4 hours</td><td rowspan="2">75%</td><td>50%</td><td>Final Practical Performance</td></tr>
<tr><td>25%</td><td>Viva-Voce</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">50</td></tr>
</table>

Test I and Test II

The subjective test of Test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 03 parts (minimum 01 from each unit) of 02 marks each. Section-B will have 04 questions of 12 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- Isolation of plasmid DNA from *E. coli* by alkaline lysis method and its quantization using spectrophotometer.
- Restriction digestion of the plasmid and estimation of the size of various DNA fragments.
- Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and Selection of recombinants.
- Demonstration of DNA sequencing by Sanger's dideoxy method.
- DNA isolation from microbial cultures and plant tissues.
- Isolation of plasmid from *E. coli* by alkaline lysis method.
- Preparation of agarose gel and preparation of buffers.
- Southern blotting of DNA from agarose gel.
- Study of restriction digestion of DNA.
- DNA sequencing studies from autoradiographs of sequencing gels and construction of autoradiographs of sequencing gels from provided template
- sequence.
- DNA fingerprinting studies from data on various cases of disputed parentage and forensic applications.

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Mushrooms: Diversity, Cultivation, and Applications

Course No.: P1BOTE109
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *This course aims to develop a comprehensive understanding of mushroom taxonomy, diversity, and identification, along with practical skills in the cultivation of edible and medicinal mushrooms. It highlights their nutritional, pharmaceutical, and industrial relevance, and explores their role in sustainability, ecosystem restoration, circular economy and entrepreneurship*

Course Outcomes: *Upon completion of the course, students will be able to:*

- *Identify and classify mushroom species using morphological, chemical, and molecular tools.*
- *Cultivate selected edible and medicinal mushrooms under controlled systems.*
- *Understand the nutritional and therapeutic value of mushrooms.*
- *Explore post-harvest applications of mushrooms.*
- *Assess the ecological and socio-economic roles of mushrooms in sustainable agriculture.*
- *Apply mushroom-based knowledge to develop innovations in: Functional foods, bioplastics and ecological restoration.*

UNIT I: Diversity and characteristics of mushrooms

1.1 Introduction to fungal taxonomy: overview of mushroom-forming fungi: Agaricomycotina and Pezizomycotina.
1.2 Collection and identification of wild mushrooms; macro- and micro morphological details, chemical tests and reagents.
1.3 Molecular characterization of mushrooms: various tools and softwares (MEGA, RAxML etc.), multigene phylogeny.
1.4 Mushroom poisoning - types, diagnosis and treatment.

UNIT II: Mushroom cultivation and value-additions

2.1 Cultivation of some commercially important edible mushrooms: *Lentinula edodes* and *Hericium erinaceus.*
2.2 Cultivation of some commercially important medicinal mushrooms: *Ganoderma lucidum* and *Cordyceps* sp.
2.3 Integrated mushroom farming, recent advances: automated cultivation systems, environmental control systems.
2.4 Nutritional and medicinal value of mushrooms, post-harvest processing, preservation, and value-added products (nutraceuticals, powders, ready to eat snacks, tea, etc.) from mushrooms, applications in pharmaceuticals and functional foods.

UNIT III: Mushrooms in sustainability

3.1 Mushrooms and circular economy: waste-to-wealth, organic farming integration, socio-economic impact: rural livelihood generation and entrepreneurship.
3.2 Ectomycorrhizal mushrooms in ecosystem restoration and forestry, mushrooms in sustainable development goals (SDGs).

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3.3 Role of edible mushrooms in food security and biocultural conservation, mushrooms in mycosilviculture and mycotourism.

3.4 Mushrooms in modern Industry and Innovation, modern applications of mushrooms: mushroom-based bioplastics, cosmetics, mushroom meat, bricks and leather.

Suggested readings

- Aggarwal, A., Sharma, Y. P. and Jangra, E. (2022) A textbook on Mushroom Cultivation theory and Practice. Newrays Publishing House, New Delhi.
- Arya, A. and Rusevska, K. (2022) Biology, Cultivation and Applications of Mushrooms. Singapore: Springer Nature Singapore.
- Gogoi, R. Rathaiah, Y. and Borah, T.R. (2019) Mushroom Cultivation Technology. (n.p.): Scientific Publishers.
- Hall, I. R., Stephenson, S. L., Buchanan, P. K., Cole, A. L. J. and Yun, W. (2010) Edible and Poisonous Mushrooms of the World. United States: Timber Press.
- Husen, A., Semwal, K.C. and Stephenson, S.L. (2023) Wild Mushrooms and Health: Diversity, Phytochemistry, Medicinal Benefits, and Cultivation. United States: CRC Press.
- Largent, D. L. and Stuntz, D.E. (1986) How to identify mushrooms to genus I: Macroscopic features. Mad River Press. Inc. Eureka.
- Largent, D.L, Johnson, D. and Watling R. (1977) How to identify mushrooms to genus III: Microscopic features. Mad River Press Inc. Eureka.
- Miles, P. G. and Chang, S. 2004. Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact. United Kingdom: CRC Press.
- Pardo-Giménez A. and Zied, C. D. (2017) Edible and Medicinal Mushrooms: Technology and Applications. Germany: Wiley.
- Pouliot, A. and May, T. (2021) Wild Mushrooming: A Guide for Foragers. Australia: CSIRO Publishing.

Note for Paper Setting

MCQ on LMS + Subjective Test	**Syllabus to be covered in the Examination**	**Time allotted for the Exam**	**% weightage(marks)**
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Test II (After 60 days)	21% to 40%	30 min	5 +5
Theory	**Syllabus to be covered in the Examination**	**Time allotted for the Exam**	**% weightage(marks)**
Major Test (After 90 days)	100%	2 hours	30
Total			**50**
Practical/Research (Thesis/project/dissertation)			
MCQ on LMS + Subjective Test	**Time allotted for the Examination**	**% weightage(marks)**	

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Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)	4 hours	25%		
External Examination	4 hours	75%	50%	Final Practical Performance
			25%	Viva-Voce
Total			**50**	

Test I and Test II

The subjective test of Test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 03 parts (minimum 01 from each unit) of 02 marks each. Section B will have 04 questions of 12 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- Field visit for collection of wild mushrooms and their identification.
- To study macroscopic (cap, gills, stipe, etc.) and microscopic features (spores, basidia, cystidia, pileipellis, etc.) for mushroom identification.
- Chemical spot tests for identification (e.g., Melzer's reagent, KOH, $FeSO_4$, Schäffer reaction).
- To study key differences between edible and poisonous species.
- Molecular phylogeny analysis using software tools like MEGA, RAxML (demo/tutorial-based).
- Hands-on demonstration of substrate preparation and mushroom cultivation.
- Estimation of nutritional content: basic tests for proteins, carbohydrates, and antioxidant content.
- Visit to a mushroom farm or rural mushroom-based enterprise.
- Preparation of a short project report on local mushroom diversity.
- Preparation of some value-added mushroom products.

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Biostatistics

Course No.: P1BOTC202
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *Variability is an inherent characteristic of biological material. To understand the nature of this variability, assess and represent it quantitatively and convert it into meaningful information, knowledge of Biostatistics is very important. It will prove helpful in designing biological experiments, collecting, analyzing and interpreting the data generated. Understanding developed by the student on these aspects will be of great practical application.*

Course Outcomes:

- *The students will get an overview of statistical concepts and help them in applying theoretical knowledge and computation skills in analysing biological data.*
- *These can be used in plant breeding, crop improvement and computational biology.*

UNIT I: Data collection, presentation and descriptive statistics

1.1 Biostatistics: conceptual understanding of statistic; variations-discrete and continuous; variable and its types.

1.2 Descriptive statistics of the distribution of any variable: mean, mode, median, variance, standard deviation, coefficient of variation, Merits and demerits of each; partitioning of data-concept of quartiles, deciles and percentiles.

1.3 Descriptive statistics of averages, dispersion, skewness and kurtosis.

1.4 Sample and population; finite and infinite populations; random and non-random methods of sampling; determination of sample size.

UNIT II: Probability distributions and various tests of significance

2.1 Probability distributions: concept, computation steps and applications of normal, binomial and Poisson distributions.

2.2 Hypothesis testing: concept, two types of errors; concept of and major differences between parametric and non-parametric tests.

2.3 Non-parametric tests: computation steps and applications of Spearman correlation, Mann Whitney U, Wilcoxon and Kruskal-Wallis tests.

2.4 Parametric tests: computation steps and applications of Z-, F and paired and unpaired t-tests.

UNIT III: Experimental designs, analysis of data and their significance

3.1 Designs of experiments: general account, principles and applications; examples of CRD, RBD; brief concept of Latin Squares, split plot and strip plot designs

3.2 Regression and correlation analyses: coefficients of correlation, regression and determination; concept and applications of logistic and non-linear regression and ANCOVA; a brief idea of GLM and HLM.

3.3 One way and two-way analysis of variance: methods and their importance in the study of variation: concept of MANOVA.

3.4 Use and importance of statistical software and/or packages in modern biology; concept and applications of PCA, LDA and RDA

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Suggested readings

- Balaam, L. N. (1972). Fundamentals of Biometry. Unwin Publishers Inc. London (Halsted Press; John Wiley & Sons).
- Datta, A. K. (2006). Basic Biostatistics and its Applications. New Central Book Agency (P) Ltd., Kolkata, India.
- Dhar, M. K. and Kaul, S. (1997). Statistics in Biology. Malhotra Publishers, Jammu.
- Gupta, S. P. (2019). Statistical Methods. Sultan Chand, New Delhi.
- Khan and Khanum. (2018). Fundamentals of Biostatistics. 5th rev ed. Ukaaz Publications, Hyderabad.
- Norman, G. R. and Streiner, D. L. (2008) Biostatistics - the Bare Essentials. B C Decker Inc., Hamilton, Canada.
- Roy, D. (2012). Plant breeding: a biometrical approach. Narosa, New Delhi.
- Senedecor, G. and Cochran, W. (1980). Statistical Methods. 7th Edn. Iowa State University Press.
- Sharma, J. R. (1998). Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers.
- Singh, R. K. and Chaudhary, B. D. (1999). Biometrical methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.
- Sokal, R. R. and Rohlf, F. J. (1973). An Introduction to Biostatistics. W. H. Freeman and Company, New York.
- Sokal, R. R. and Rohlf, F. J. (2001). Biometry-The Principles and Practice of Statistics in Biological Research. W. H. Freeman and Company, New York.
- Sukhatme, P.V. and Amble, V. N. (1976). Statistical Methods for Agricultural Workers. ICAR, New Delhi.

Note for Paper Setting

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Theory	**Syllabus to be covered in the Examination**	**Time allotted for the Exam**	**% weightage(marks)**
Major Test (After 90 days)	100%	2 hours	30
Total			**50**

Practical/Research (Thesis/project/dissertation)

MCQ on LMS + Subjective Test	**Time allotted for the Examination**	**% weightage(marks)**		
Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)	4 hours	25%		
External Examination	4 hours	75%	50%	Final Practical

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				Performance
			25%	Viva-Voce
Total			50	

Test I and Test II

The subjective test of Test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

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List of Practicals

- Calculation of mean, mode, median, standard deviation and coefficient of variation.
- Skewness and Kurtosis- coefficients and probability.
- Frequency and probability distributions.
- Students't-test, F-test, z-test, one-way and two-way ANOVA.
- Non-parametric tests-chi-square, Kruskal-Wallis, Spearman's correlation, Mann-Whitney U, Wilcoxon Tests
- Correlation and regression analysis.
- ANCOVA and MANOVA
- Cluster analysis
- PCA, RDA and LDA
- Use of statistical software/packages in data entry, computation and analyses

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Biodiversity Informatics

Course No.: P1BOTE205
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *The objective of this course is to introduce students to the foundational concepts, standards, and tools of biodiversity informatics. It aims to develop skills for managing, digitizing, and validating biodiversity data from diverse sources, including field surveys, herbaria, and citizen science. Students will learn about key data standards such as Darwin Core and ABCD scheme, geospatial data applications, and data quality control techniques. The course also emphasizes practical applications of biodiversity data in conservation planning, species distribution modeling, and policy-making, preparing students to effectively utilize informatics in biodiversity research and management.*

Course Outcomes: *After completing this course, students will be able to:*

- *Understand the scope, importance, and global initiatives of biodiversity informatics, along with the challenges in biodiversity data management.*
- *Identify various types and sources of biodiversity data and apply methods for data collection and digitization, including herbarium digitization techniques.*
- *Apply international data standards and protocols (e.g., Darwin Core, ABCD Schema) for biodiversity data integration and sharing.*
- *Demonstrate skills in biodiversity data validation, cleaning, and quality control using tools like OpenRefine and GBIF Validator.*
- *Design and manage biodiversity databases using DBMS principles and evaluate the use of cloud platforms for scalable biodiversity data storage.*

UNIT I: Biodiversity informatics and biodiversity data

1.1 Concepts & challenges: definition, scope, applications and importance of biodiversity informatics, global initiatives and challenges of biodiversity informatics.

1.2 Data types & sources: definition and importance of biodiversity data and data sources; field surveys, herbarium records, literature, and citizen science; types of biodiversity data (occurrence, taxonomic, trait, ecological, genetic, spatial)

1.3 Data acquisition: data collection and digitization, data collection tools (open data kit, mobile apps), herbarium digitization methods.

1.4 Practical uses: applications of biodiversity data in conservation planning and prioritization, species distribution modelling, climate change studies, policy and decision-making, biodiversity indicators and red lists.

UNIT II: Data standardization and protocols

2.1 Biodiversity Information Standards: Darwin Core (DwC) taxonomic databases, working groups: structure, elements, importance.

2.2 ABCD (Access to Biological Collection Data) Schema and tools: structure and elements, tools or editors (BioCASe provider software, XML editors).

2.3 Geospatial data basics: use of GPS and maps in biodiversity research, coordinate systems and formats.

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2.4 Data quality control: data cleaning, common issues (duplicates, taxonomic errors, missing data), tools for validation (OpenRefine, GBIF validator, Taxon Match tools)

UNIT III: Database Management System (DBMS)

3.1 DBMS basics & components: brief introduction to DBMS, components of DBMS (engine, query processor, storage).
3.2 Entity-Relationship (ER) modeling: database design principles, ER diagrams (entities, attributes, relationships).
3.3 Normalization: basic concepts of 1NF, 2NF, 3NF; designing schema for ethnomedicinal plant data.
3.4 Cloud database platforms: google firebase, google cloud SQL and mongoDB atlas-advantages and challenges of cloud databases.

Suggested readings

- Bisby, F.A., Roskov, Y., Orrell, T., Nicolson, D., Paglinawan, L., Bailly, N., Kirk, P.M., Bourgoin, T., Baillargeon, G., and Ouvrard, D. (Eds.) (2021). Species 2000 & ITIS Catalogue of Life, Naturalis.
- Dubois, E., and Bizer, C. (2011). Linked Data: Structured Data on the Web, Morgan & Claypool.
- Elmasri, R. and Navathe, S.B. (2015). Fundamentals of Database Systems, 7th Edition, Pearson.
- Kroenke, D.M. and Auer, D.J. (2019). Database Concepts, 7th Edition, Pearson.
- Pillai, R.N. and Sharma, V.K. (2018). Biodiversity Informatics, Elsevier.
- Wheeler, Q.D., and Meier, R. (2000). Species Concepts and Phylogenetic Theory: A Debate, Columbia University Press.

Note for Paper Setting

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Total			**50**
Practical/Research (Thesis/project/dissertation)			
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Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)	4 hours	25%	

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External Examination	4 hours	75%	50%	Final Practical Performance
			25%	Viva-Voce
Total			**50**	

Test I and Test II

The subjective test of Test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

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List of Practicals

- Downloading and cleaning occurrence data from GBIF.
- Visualizing species distribution using QGIS.
- Conducting a simple MaxEnt modeling exercise.
- Data mining from public databases (e.g., BOLD, IUCN).
- Creating a biodiversity dataset and publishing a mock Darwin Core Archive.
- Integrating local field data with global datasets.

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Industrial Microbiology and Public Health

Course No.: P1BOTE206	**Maximum Marks: 50**
Credits: 2	**Test I: 10 Marks**
Duration: 2 hrs	**Test II: 10 Marks**
	Major Test: 30 Marks

Course Objectives: *This course aims to introduce students to the foundational concepts of industrial microbiology and public health microbiology. It provides an overview of microbial roles in fermentation processes, enzyme production, and bioreactor applications. The course also explores the beneficial aspects of microbes in gut health, fermented foods, and probiotic functions, alongside essential insights into microbial infections, antimicrobial resistance, and the basic principles of antibiotic sensitivity testing. The course emphasizes the contrasting roles of beneficial and pathogenic microbes, highlighting their impact on food systems, human health, and sustainable biotechnological applications.*

Course Outcomes:

After successful completion of this course, students will be able to:

- *Understand fundamental concepts of industrial microbiology, including microbial fermentation, enzyme production, and bioreactor design.*
- *Recognise the role of beneficial microbes in gut health, food fermentation, and sustainable applications.*
- *Identify common microbial pathogens and describe basic mechanisms of infection and disease.*
- *Demonstrate awareness of antimicrobial resistance and interpret basic antibiotic sensitivity testing methods.*
- *Develop practical microbiology skills, including microbial isolation, media preparation, and microscopic identification of industrial and clinical microbes.*
- *Apply microbiological knowledge to address real-world issues in food, health, and public sectors with a focus on safety and sustainability.*

UNIT I: Fundamentals of industrial microbiology

1.1 Overview of industrial microbiology; important characteristics of industrial microbes; taxonomic groupings of industrial microbes.

1.2 Fermentation: batch, fed-batch and continuous fermentation; dilution rate and microbial growth in a chemostat and a turbidostat.

1.3 Bioreactor design, types and key components; commercial production of ethanol and citric acid, importance.

1.4 Microbial enzymes: industrial production and application of amylase and protease.

UNIT II: Microbes for life in health and sustainability

2.1 Composition and diversity of gut microbiota; factors influencing gut microbiome (diet, antibiotics, lifestyle); role in digestion, immunity, and metabolic health

2.2 Gut-brain axis and microbial influence on mental health; prebiotics- concept, classification, dietary sources and importance

2.3 Probiotic foods and beverages: mechanisms of health promotion-nutrient competition, barrier function, antimicrobial production, nervous system signalling, immunomodulation.

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2.4 Fermented foods: fruits, vegetables, and cereal- or legume-based products.

UNIT III: Microbial risks: infections, diseases and resistance

3.1 Clinical syndromes and pathogenesis of bacterial (staphylococcal diseases) and fungal (*Candida, Aspergillus*) infections.
3.2 Mechanism of action and diseases caused by viruses (seasonal flu) and prions (Creutzfeldt–Jakob disease, Scrapie, Kuru, Bovine Spongiform Encephalopathy).
3.3 Resistance to antimicrobial drugs: mechanisms of antibiotic resistance, non-genetic and genetic basis of drug resistance.
3.4 Antibiotic sensitivity testing: disc diffusion tests (Kirby–Bauer, Stokes and Primary disc diffusion tests), dilution tests (Broth & Agar dilution method and Epsilometer test).

Suggested readings

- Flint, S.J., et al., (2015) Principles of Virology. American Society for Microbiology.
- Carter, J. B. and Saunders, V. A. (2007) Virology Principles and Applications John Wiley & Sons Ltd.
- Okafor, N. and Okeke, B. C. (2018) Modern Industrial Microbiology and Biotechnology (2nd ed.). CRC Press.
- Parija, S. C. (2012) Textbook of Microbiology & Immunology (2nd rev. ed.). Elsevier India.
- Parija, S. C. (2020) A textbook of microbiology and immunology (3rd ed.). Elsevier.
- Pepper, I. L., Gerba, C. P. and Gentry, T. J. (Eds.). (2014) Environmental Microbiology (3rd ed.). Elsevier/Academic Press.
- Saxena, S. (2015) Applied Microbiology. Springer India.
- Sumbali, G. (2010) The Fungi. 2nd Edn. Narosa Publishing House, New Delhi.
- Sumbali, G. and Mehrotra, R.S. (2009) Principles of Microbiology. 1st Edn. Tata McGraw-Hill Publishing Co. Ltd. New Delhi.
- Waites, M. J., Morgan, N. L., Rockey, J. S. and Higton, G. (2001) Industrial Microbiology: An Introduction (1st ed.). Wiley Blackwell.

Note for Paper Setting

MCQ on LMS + Subjective Test	**Syllabus to be covered in theExamination**	**Time allotted for the Exam**	**% weightage(marks)**
Test I (After 30 days)	Up to 20%	30 min	5 +5
Test II (After 60 days)	21% to 40%	30 min	5 +5
Theory	**Syllabus to be covered in theExamination**	**Time allotted for the Exam**	**% weightage(marks**
Major Test (After 90 days)	100%	2 hours	30
Total			**50**
Practical/Research (Thesis/project/dissertation)			
MCQ on LMS + Subjective Test	**Time allotted for the Examination**	**% weightage(marks)**	
Mid Term Appraisal	4 hours	25%	

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(Evaluation of daily practical performance/ Practical Assignment/ Field Study)				
External Examination	4 hours	75%	50%	Final Practical Performance
			25%	Viva-Voce
Total			**50**	

Test I and Test II

The subjective test of Test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 03 parts (minimum 01 from each unit) of 02 marks each. Section-B will have 04 questions of 12 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- Isolation and purification of Microorganisms (Fungi/bacteria) from soil.
- Screening of Industrially Important Microorganisms for the production of enzymes.
- Preparation and Sterilisation of Fermentation Media
- Identification of probiotic microbes from commercial yoghurt/probiotic drinks.
- Preparation of curd/idli batter/pickles and identification of dominant microbes.
- Microscopic examination and identification of causal agents of different types of mycoses.

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UNIVERSITY OF JAMMU
Syllabus for PG Program in BOTANY
(As per NEP–2020)
PG SEMESTER–II
(Syllabus for the examinations to be held in the years December 2026, 2027, 2028)

Plant Molecular Stress Physiology

Course No.: P1BOTE207
Credits: 2
Duration: 2 hrs

Maximum Marks: 50
Test I: 10 Marks
Test II: 10 Marks
Major Test: 30 Marks

Course Objectives: *This course is designed to enhance students' knowledge of the molecular adaptations and methods developed to evaluate a plant's potential for abiotic stress management.*

Course Outcomes: *The students will be able to:*

- *Understand the molecular mechanisms, including DNA/RNA modifications and regulatory proteins, that enable plants to tolerate abiotic stresses.*
- *Analyze the roles of gene regulatory networks, transcription factors and protein interactions in stress response pathways.*
- *Apply advanced molecular techniques such as transcriptome analysis, RNA-seq, scRNA-seq and GWAS to assess and enhance plant stress tolerance.*

UNIT I: Molecular adaptations to combat abiotic stresses

1.1 DNA modifications: types, and their role in stress management in plants.
1.2 RNA modifications: types and functions in abiotic stress mitigation in plants.
1.3 Regulatory proteins: diversity (writers, readers, and erasers) and importance in stress tolerance in plants.
1.4 Plant metabolome: brief overview and significance in stress management.

UNIT II: Regulation of abiotic stress through different routes

2.1 Gene regulatory network: overview, types, and role in stress management in plants.
2.2 Transcription factors: databases, main types, and their role in salinity, heat, and cold tolerance.
2.3 Zinc Finger Nucleases: overview, their engineering, and applicability role in plant stress management.
2.4 Protein-protein interactions: concept and their impact on abiotic stress management in plants.

UNIT III: Stress potential of plants

3.1 Transcriptome analysis: concept, overview of procedure, and importance in the discovery of potential factors conferring abiotic stress tolerance.
3.2 RNAseq analysis: concept, overview of procedure, and applications in stress management studies in plants.
3.3 Single-cell RNAseq (scRNA-seq): general idea, procedural overview, difference between RNA-seq and scRNA-seq, applications in the discovery of potential genetic factors implicated in stress management in plants.
3.4 Genome Wide Association Studies (GWAS): brief overview, latest types, SNP discovery and analysis.

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Suggested readings

- He, C. (2015) RNA modification (Vol. 560). Academic Press. In Methods in Enzymology Volume 560.
- Kulski, J. (Ed.). (2016) Next generation sequencing: advances, applications and challenges.
- Mandal, S. (Ed.). (2024) Reverse Engineering of Regulatory Networks. Humana Press.
- Song, Q. and Tao, Z. (Eds.). (2023) Transcription factor regulatory networks. Springer US.
- Yadav, C. B., Pandey, G., Muthamilarasan, M. and Prasad, M. (2018) Epigenetics and epigenomics of plants. Plant Genetics and Molecular Biology, 237-261.
- Latest review and research articles.

Note for Paper Setting

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Test I (After 30 days)	Up to 20%	30 min	5 +5	
Test II (After 60 days)	21% to 40%	30 min	5 +5	
Theory	**Syllabus to be covered in theExamination**	**Time allotted for the Exam**	**% weightage(marks)**	
Major Test (After 90 days)	100%	2 hours	30	
Total			**50**	
Practical/Research (Thesis/project/dissertation)				
MCQ on LMS + Subjective Test	**Time allotted for the Examination**	**% weightage(marks)**		
Mid Term Appraisal (Evaluation of daily practical performance/ Practical Assignment/ Field Study)	4 hours	25%		
External Examination	4 hours	75%	50%	Final Practical Performance
			25%	Viva-Voce
Total			**50**	

Test I and Test II

The subjective test of test I and Test II would consist of two short answer type questions (05 marks each). Students are required to answer one question. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The major test will comprise of two sections, Section-A and Section-B. Section-A will have compulsory questions comprising 03 parts (minimum 01 from each unit) of 02 marks each.

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Section-B will have 04 questions of 12 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B.

List of Practicals

- Learning of metabolome shift in wheat, rice/maize under drought and salinity stress.
- Designing a gene regulatory network for typical phosphate-deficient conditions.
- Data mining using Transcription Factor Databases for WRKY and bHLH for their role in salinity tolerance.
- STRING analysis and UNIPROT analysis for analyzing interactions of proteins
- Learning RNAseq analysis using publicly available databases.
- Methods of analyzing transcriptome data and its validation using publicly available data.
- TASSEL software learning for genomic data filtration.
- R-project for handling genomic data.

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