GONDWANA UNIVERSITY, GADCHIROLI

FACULTY OF SCIENCE & TECHNOLOGY

SYLLABUS

FOR

B.Sc.

BOTANY

S e m e s t e r – V and VI

As per National Education Policy – 2020

(w.e.f.: 2026 – 27)

Gondwana University, Gadchiroli
NEP 2020 U.G. PROGRAMME SESSION 2026-27
Faculty of Science and Technology
Programme Name - B.Sc. Botany SemesterV (Level-5.5)

Sr. No.	Course Category	Subject name	Total Credit	Teaching Scheme (Hrs)			Examination Scheme									Total Marks
							Theory					Practical				
				Theory	Practical	Total Hrs.	UA	CA	Total Mark	Min. Passing	Duration of Exam (Hrs.)	UA	CA	Total Mark	Min. Passing	
1	Major Subject (Core Subject)	Paper V 2 credits Theory + 2 credits Practical **Plant Biochemistry and Physiology**	04	02	04	06	40	10	50	20	03	30	20	50	25	100
		Paper VI 2 credits Theory + 2 credits Practical **Cell Biology, Genetics and Plant Breeding**	04	02	04	06	40	10	50	20	03	30	20	50	25	100
2	Major Subject (Discipline Specific Elective)	Paper DSE I 2 credits Theory + 2 credit Practical Any one from Major Elective Subject Basket	04	02	04	06	40	10	50	20	03	30	20	50	25	100
3	Minor Subject (Core Subject)	Paper III 2 credits theory + 2 credit Practical **Economic Botany**	04	02	04	06	40	10	50	20	03	30	20	50	25	100
4	VSC	Based on Major subject. Any one from VSC Basket	02	--	04	04						30	20	50	25	50
5	FP/CEP	Based on Major Subjects (30 hrs/credit)	02	--	04	04	--	--	--	--	--	30	20	50	25	50
6	IKS SS	IKS in Botany - I	02	02	-	02	40	10	50	20	02	-	-	-	-	50
Total			22	10	24	34	200	50	250	100	14	180	120	300	150	550

Annexure – I

NEP2020 B. Sc. Botany Major

B. Sc. Semester V

Basket for Discipline Specific Elective – I

Options	DSE – I Subjects
I	Molecular Biology and Plant Biotechnology - I
II	Ethnobotany, Ethnomedicine and Phytochemistry - I
III	Mycology and Plant Pathology – I
IV	Paleobotany – I
V	Biodiversity Conservation - I
VI	Reproductive Biology of Angiosperms - I

Annexure – II

NEP2020 B. Sc. Botany Major

B. Sc. Semester V

Basket for Vocational Skill Course (VSC)

Options	Vocational Skill Courses
I	Plant Growth Medium
II	Modern Farming Techniques

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Paper – V (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 501

Plant Biochemistry and Physiology

Credits: 02 **Hours: 30 Hours**

UNIT I: Fundamentals of Plant Biochemistry: Structures, types and functions of Biomolecules. (08 Hours)

1. **Carbohydrates:**
   - Definitions and General Structure, α and β glycosidic bonds
   - **Types:** Monosaccharides, Disaccharides and Polysaccharides (Homo and Hetero)
   - **Functions:** Energy source, Energy storage and Structural Components
2. **Proteins:**
   - Definition, amino acids and peptide bond
   - Primary, Secondary, Tertiary and Quaternary structure.
   - **Functions:** Structural, Enzymes, Hormones and Transport.
3. **Lipids**
   - Definition, fatty acids, ester linkages.
   - Saturated fatty acids, unsaturated fatty acids, Triglycerides (Fats and Oil), Phospholipids, Steriods, Waxes.
   - **Functions:** Energy Storage, Structural components, Insulation and Protection, Hormones and Signaling, Waterproofing, Vitamins storage and transport),
4. **Nucleic Acids**:
   - Definition, nucleosides and nucleotides, Glycosidic bond, Phosphodiester linkage.
   - Basic structure of DNA and RNA
   - **Functions:** Storage of Genetic Information, Transmission of Hereditary Information, role in protein synthesis, Ribosomes and ribozymes.
5. **Enzymes**
   - Definition and general structure, Active site, C and N-terminals
   - **Types:** Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases and Ligases.
   - **Functions:** Catalysis, Digestion, DNA replication, Cellular processes, Building and Repair.

UNIT II: Introduction to Plant Secondary Metabolites (07 Hours)

1. **Plant Secondary Metabolites**
   - Definition, Characteristics and Importance
   - Types: Alkaloids, Phenolics, Terpenoids, Polyketides, Specialized amino acids and peptides
   - **Biosynthetic Pathways:** Shikimate pathway, Phenylpropanoid pathway
2. **Alkaloids**
   - Definition and general characters
   - **Types**: True alkaloids, Protoalkaloids and Pseudoalkaloids.
   - **Functions**: Plant defence, Physiological effects, Medicinal uses, Metabolic role and antioxidant activity.
3. **Phenolics**
   - Definition and general characters
   - **Types**: Simple phenols, Phenolic acids, Flavonoids, Tannins, Lignans and Stilbenes
   - **Functions**: Plant defence, Antioxidant activity, UV protection, Structural support and Pigmentation
4. **Terpenoids**

- Definition and general characters
- **Types**: Monoterpenoids, Sesquiterpenoids ,Diterpenoids, Sesterterpenoids, Triterpenoids, Tetraterpenoids and Polyterpenoids.
- **Functions:** Plant defence, Aromatic compounds, Colour pigments, Flavour compounds and Medicinal properties.

5. Polyketides

- Definition and general characters
- Type I, Type II and Type III
- **Functions**: Antimicrobial activity, Anticancer activity, Immunosuppressive activity and Ecological role

UNIT III: Principles of Plant Physiology (08 Hours)

Plant–Water Relations

1. Water Absorption

- Active absorption and Passive absorption
- Role of root hairs in water absorption
- Apoplast pathway and Symplast pathway
- Factors Affecting Water Absorption

2. Water Transport

- Structure of Xylem
- Root Pressure Theory, Capillary Theory, Cohesion–Tension Theory

3. Transpiration

- Definition and types
- Significance, factors affecting on transpiration
- Guttation

Mineral Nutrition

4. Essential mineral nutrients

- Definition, criteria of essentiality and classification (Macro nutrients and micronutrients)
- The Dose-Response Rule (Paracelsus Principle)
- Role, deficiency symptoms and toxicity of Nitrogen (N), Phosphorus (P) and Potassium (K) Calcium (Ca), Magnesium (Mg) and Sulphur (S)
- Role, deficiency symptoms and toxicity of Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo) and Zinc (Zn)

UNIT IV: Physiological Processes (07 Hours)

1. Photosynthesis

- Definition and Significance
- Light absorption and energy transfer
- Quantum requirement and quantum yield, Red drop and Emerson's enhancement effect
- Light dependent reactions: Cyclic and non cyclic photophosphorylation
- Light independent reactions: Calvin Cycle (C_3 pathway), C_4 pathway, CAM pathway
- Factors affecting photosynthesis

2. Respiration

- Definition, and Significance
- Glycolysis
- Krebs (TCA/Citric Acid) Cycle
- Electron Transport Chain (Oxidative Phosphorylation)
- Respiratory Quotient (RQ)
- factors affecting respiration in plants

3. **Photorespiration**
   - Role and significance
   - **Mechanism**

Suggested Laboratory Exercises: (Any 10 Exercise representing all the four units)

1. Qualitative and quantitative analysis of Carbohydrates in local crops.
2. Qualitative and quantitative analysis of Proteins in local crops.
3. Enzyme assays (Amylase/Catalase/Acid Phosphatase/Phenylalanine Lyase/Gulcanase/Chitinase) using extracts from regional plant species.
4. Extraction and profiling (Qualitative or Quantitative) of secondary metabolites (Alkaloids/ Phenolics/Tanins/Falvonoids) from indigenous medicinal plants.
5. Measurement of transpiration and water potential in local plants.
6. Demonstration of differential Transpiration rates on Upper and Lower surfaces of plants using Bell Jar and Cobalt Chloride Method.
7. Demonstration of root pressure in plant.
8. Demonstration of Ascent of sap.
9. Demonstration of amount of water absorbed and the amount of water transpired by plant are approximately equal.
10. Determination of the osmotic potential/pressure of vacuolar sap by plasmolytic method.
11. Demonstration of photosynthetic pigments in native crops using chromatography.
12. Demonstration of effect of abiotic stress on Photosynthetic rate in *Hydrilla*.
13. Demonstration of necessity of Light for Photosynthesis.
14. Demonstration of necessity of light, chlorophyll, water and CO_2 for Photosynthesis.
15. Demonstration of cellular respiration in local plant species.
16. Demonstration of Anaerobic Respiration.
17. Demonstration of evolution of CO_2 during respiration.
18. Demonstration of release of energy in the form of heat during respiration.
19. Assessment of physiological responses to abiotic stress (e.g., local varieties under drought).
20. Study effects of local environmental stresses (drought, salinity) on plant physiology.
21. Case studies on physiological adaptations of regional flora.

References:

Textbooks

- Plant Physiology, Development and Metabolism by Satish C Bhatla & Manju A. Lal. Springer Nature, 2018.
- A Textbook of Plant Physiology, Biochemistry and Biotechnology by Mohit Verma & S K Verma. S Chand Publishing.
- Plant Biochemistry, 6th Edition by Birgit Piechulla, Hans-Walter Heldt, et al. Elsevier, 2025.
- Plant Biochemistry and Molecular Biology, 2nd Edition edited by Peter J. Lea & Richard C. Leegood. Wiley, 1998.
- BOTANY (PLANT PHYSIOLOGY & BIOCHEMISTRY) Sem-VI. EbookseLibrary.
- Plant Physiology and Biochemistry. Uttarakhand Open University, MSCBOT 601, 2022.
- Plant Biology by Linda E. Graham, James M. Graham, and Lee Warren Wilcox. Prentice Hall, 2003.
- Botany: An Introduction to Plant Biology by James D. Mauseth. Jones and Bartlett, 2003.

Reference Books & Manuals

- Practicals in Plant Physiology and Biochemistry. Scientific Publishers, 2013.
- Methods in Plant Biochemistry and Molecular Biology by William V. Dashek, CRC Press, 1997 (also available as eBook).

Research Journals & Articles

- Plant Physiology and Biochemistry. Elsevier (peer-reviewed journal; see publisher's website for the latest research and review articles).

- ‘Guide to Reference and Information Sources in Plant Biology’ by Diane Schmidt et al., Libraries Unlimited, 2006—provides bibliographies, databases, and a curated list of journals and handbooks in plant sciences.

Digital Contents

- Plant Biochemistry and Physiology OpenCourseWare and lecture notes (e.g., materials from Uttarakhand Open University).
- Curated web resource lists for Plant Biology from University of Illinois—includes web-accessible bibliographies, databases, dictionaries, protocols, and major journals.
- eBook versions of classic and modern plant biochemistry textbooks (see publisher sites such as Springer, Elsevier, or CRC Press for digital access).
- https://www.sciencedirect.com/journal/plant-physiology-and-biochemistry/special-issue/10SGW8XDCT
- https://pmc.ncbi.nlm.nih.gov/articles/PMC3315222/
- https://plantbiologyconference.com/program/scientific-sessions/plant-physiology-and-biochemistry.
- https://www.pondiuni.edu.in/wpcontent/uploads/2021/01/Syllabus_Affiliated_ArtsScience_M.Sc_.-BotanyCBCS-2020-21.pdf
- https://ramjas.du.ac.in/adminramjas/web/syllabus_new/Botany_LOCF.pdf
- https://uou.ac.in/sites/default/files/slm/BSCBO-303.pdf

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Major Paper – VI (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 502

Cell Biology, Genetics and Plant Breeding

Credits: 02 **Hours: 30**

UNIT I: Cell Biology – Principles and Innovations (07 Hours)
Basic Principles:

- Structure and function of Prokaryotic and Eukaryotic cells,
- Ultrastructure of cell organelles and their functions (*Nucleus, Mitochondria, Chloroplasts, Endoplasmic Reticulum, Golgi Apparatus, Vacuole*),
- Membrane structure (*Fluid Mosaic model*) and transport mechanisms (*Diffusion, Osmosis, Active transport*),
- Cell cycle and regulation of Mitosis and Meiosis.

Recent Advancements: Live-cell imaging and Fluorescence Microscopy, Organelle Biogenesis and Targeted Protein Trafficking, Single-Cell Omics in Plant Research.

UNIT II: Genetics - Mendelian and Molecular Genetics (08 Hours)
Basic Principles:

- Mendelian laws of inheritance (*Monohybrid, Dihybrid crosses and ratios, Multiple alleles, Gene Interactions, Pleiotropy, Polygenic inheritance*),
- Chromosomal theory of inheritance (*Linkage and crossing over*),
- Chromosomal aberrations (*Numerical and Structural*),
- Cytoplasmic inheritance (*Leaf variegation, Cytoplasmic Male Sterility (CMS), Iojap in Maize*).

Recent Advancements: Molecular markers, Gene mapping in plants, Epigenetics and regulation of gene expression in plants, Advances in next-generation sequencing and genomic data analysis.

Unit III: Genetics - Biodiversity and Contemporary Issues (07 Hours)
Genetic Resources and Biodiversity:

- Concepts, values, conservation strategies of Germplasm (*collection, maintenance, and evaluation*),
- Principles and methods of Plant Biotechnology (*Micropropagation, Somaclonal variations, Somatic Hybridization*).

Recent Advancements: Use of genome-editing for conservation of endangered/endemic species, Field applications of gene-edited crops (local and global examples), Regulatory, ethical, and patent challenges in use of new plant breeding technologies.

Unit IV: Applied Plant Breeding (08 Hours)
Objectives and types of Plant Breeding:

- Selection, Hybridization, Mutation breeding,
- Heritability, Genetic variation, Selection indices,
- Breeding for disease resistance and stress tolerance.

Recent Advancements: CRISPR-Cas and genome editing techniques in crop improvement, AI- and data-driven breeding approaches—Predictive Analytics for trait selection, Speed breeding using controlled light and photobiological tools.

Suggested Laboratory Exercises: (Any 10 Exercise representing all the four units)

1. Microscopic examination of local plant cell types (e.g., rice, pulses, millets etc.).

2. Isolation, staining and counting of cell organelles in indigenous species.
3. Analysis of mitosis/meiosis in regionally important crops.
4. Mendelian ratio analysis using coloured beads.
5. DNA extraction from regional plants.
6. PCR demonstration for local cultivar identification.
7. Demonstration of Hybridization techniques on local crops.
8. Assessment of qualitative and quantitative traits in indigenous plant varieties.
9. Application of AI-based tools (demonstration or virtual toolkits) for local breeding challenges.
10. In vitro propagation of local medicinal or food crops.
11. Survey/design of mini germplasm banks for local varieties.
12. Case studies on regional biodiversity and conservation needs.

References:

Textbooks

- Cell Biology, Genetics and Plant Breeding by Dr. Harish Pal Bhati & Dinesh Kumar (Amiga Press).
- A Text Book of Botany: Cell Biology, Genetics & Plant Breeding by Dr. U.N. Bhale & Dr. A.B. Ade.
- Cell Biology, Genetics & Plant Breeding (Botany I Year), Neelkanth Publishers.
- Principles of Plant Genetics and Breeding, 3rd Edition by George Acquaah (Wiley).
- Covers both classical and molecular aspects, recent advances (CRISPR, genome editing), molecular markers, and practical breeding strategies.

Reference Books & Manuals

- Cell Biology, Genetics and Plant Breeding, KDPublications.
- Strong focus on cell structure, chromosome organization, Mendelian and post-Mendelian genetics, selection, hybridization, and mutation.

Research Papers & Review Articles

- Plant Cell, Elsevier: Leading journal for latest research in plant cell biology, genetics, and related biotechnological advances.
- Theoretical and Applied Genetics, Springer: Cutting-edge research in plant genetics and breeding methodologies.
- Critical reviews and original articles in journals such as:Plant Physiology (Elsevier), Genetics (Genetics Society of America), Frontiers in Plant Science.

Articles & Digital Content

- Cell Biology, Genetics and Plant Breeding PDF materials from Alagappa University MSc Botany Syllabus.
- Covers detailed units on cell structure, organelles, chromosomes, cell division, Mendelian genetics, mutation, population genetics, breeding methods, and biotechnological advances.
- Wiley companion website for Principles of Plant Genetics and Breeding.
- Includes artwork, instructor resources, topic summaries, and assessment questions.
- Online course materials and MOOC modules for Genetics and Plant Breeding from leading universities (check resources from MIT OCW, NPTEL).
- https://www.frontiersin.org/journals/genome_editing/articles/10.3389/fgeed.2025.1623540/pdf
- https://www.isaaa.org/blog/entry/default.asp?BlogDate=1%2F22%2F2025
- https://middlemarketgrowth.org/agriculture-plant-genetics-innovation-m-a-partners/
- https://farmonaut.com/usa/ai-driven-crop-breeding-5-ways-it-transforms-nc-agriculture
- https://www.sciencedirect.com/science/article/pii/S2214514125001370
- https://www.sciencedirect.com/science/article/abs/pii/S0167779925001386
- https://www.tandfonline.com/doi/full/10.1080/21645698.2025.2524236

Gondwana University, Gadchiroli

Theory Question Paper Pattern

B. Sc. SEMESTER – V BOTANY (Major Papers V and VI)

Time: 03 Hours **Total Marks: 40**

Note: 1) All questions are compulsory and carry equal marks.
2) Draw well labelled diagram wherever necessary, but NOT necessary for Q. No. 5

Question 1. Write in detail **4 M x 2 = 08 M**

a) Unit – I
b) Unit – I

OR

c) Unit – II
d) Unit – II

Question 2. Write in detail **4 M x 2 = 08 M**

a) Unit – III
b) Unit – III

OR

c) Unit – IV
d) Unit – IV

Question 3. Write in short **2 M x 4 = 08M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit –I

OR

e) Unit –II
f) Unit – II
g) Unit – II
h) Unit – II

Question 4. Write in short **2 M x 4 = 08 M**

a) Unit – III
b) Unit – III
c) Unit – III
d) Unit –III

OR

e) Unit –IV
f) Unit – IV
g) Unit – IV
h) Unit – IV

Question 5. Write answers to any Eight questions in one or two lines only. **1 M x 8 = 08 M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit – II
e) Unit – II
f) Unit – II
g) Unit – III
h) Unit – III
i) Unit – III
j) Unit – IV
k) Unit – IV
l) Unit – IV

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SEMESTER –V (Level – 05.5)
Practical Examination – Botany (Major - V)
Plant Biochemistry and Physiology
(Based on Theory Major Paper - V)
2 Credits; 60 hours) (UA-30 + CA-20)
Course Code – USCBOT 503

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] from Plant Biochemistry 05 M

Que. 2: Any one Exercise [B] from Plant Biochemistry 05 M

Que. 3: Any one Exercise [C] from Plant Physiology 05 M

Que. 4: Any one Exercise [D] from Plant Physiology 05 M

Que. 5: SPOTTINGS 06 M
- SPOT – E : Plant Biochemistry
- SPOT – F : Plant Biochemistry
- SPOT – G : Plant Biochemistry
- SPOT – H: Plant Physiology
- SPOT – I : Plant Physiology
- SPOT – J: Plant Physiology

Q 6: Submission of duly certified Practical Record 02 M

Q 7: Viva-Voce. 02 M

SEMESTER –V (Level – 05.5)
Practical Examination – Botany (Major - VI)
Cell Biology, Genetics and Plant Breeding
(Based on Theory Major Paper - VI)
2 Credits; 60 hours) (UA-30 + CA-20)
Course Code – USCBOT 504

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] from Cell Biology 04 M

Que. 2: Any one Exercise [B] from Cell Biology 04 M

Que. 3: Any one Exercise [C] from Genetics 06 M

Que. 4: Any one Exercise [D] from Plant Breeding 06 M

Que. 5: SPOTTINGS 06 M
- SPOT – E : Cell Biology
- SPOT – F : Cell Biology
- SPOT – G : Genetics
- SPOT – H: Genetics
- SPOT – I : Plant Breeding
- SPOT – J: Plant Breeding

Q 6: Submission of duly certified Practical Record 02 M

Q 7: Viva-Voce. 02 M

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Major Elective (DSE-I) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 505

Molecular Biology and Plant Biotechnology - I

Credits: 02 **Hours: 30**

UNIT I: Molecular Basis of Heredity (07 Hours)
Basic Principles:

1. Historical development of Molecular Biology –
    - *Definition and scope,*
    - *Contribution of Friedrich Miescher, Richard Altmann, Phoebus Levene, Torbjorn Caspersson, Einar Hammerstein, Frederick Griffith, Oswald Avery, Colin MacLeod, and Maclyn McCarty, Erwin Chargaff, Alfred Hershey and Martha Chase, Fraenkel and Conrat, Rosalind Franklin, James Watson, Francis Crick, Jacob and Monod*,
2. Chemical composition –
    - *Deoxyribose and Ribose Sugars, Nitrogen Bases, Phosphate, Nucleosides, Nucleotides.*
3. Structure -
    - *Watson-Crick DNA double helix*
4. Types –
    - *B, A, & Z forms of DNA,*
    - *rRNA, mRNA, tRNA (Clover Leaf Model), snRNA, snoRNA, miRNA, siRNA*
5. Properties –
    - *Charge, Solubility, Stability, Directionality, Length* of nucleic acids (*DNA & RNA*),
6. Organization of Genome
    - Viral Genome (Single stranded linear and circular DNA (ssDNA), Double stranded linear and circular DNA (dsDNA), Single stranded liner and circular RNA (ssRNA), Double stranded liner RNA (dsRNA),
    - Prokaryotic Genome (*Nucleoid, single, circular double stranded DNA, associated RNA and proteins (HU, H-NS, HIF, FIS, Dps and P) and their probable role, Plasmid*),
    - Eukaryotic genome (*Primary structure-Nucleosome, Nucleosome fibre (Beaded string); Higher order structure- Solenoid fibre, Chromatin Fibre, Chromonema, Chromosome, Heterochromatin and Euchromatin*),
7. Denaturation and Renaturation of DNA (*definition and processes*), Cot curve (*interpretation and applications*).

UNIT II: DNA Replication (08 Hours)
DNA replication in prokaryotes:

1. Enzymes and Proteins associated with Prokaryotic DNA replication
    - *DNA Helicase (DnaB),*
    - *DNA Primase (DnaG),*
    - *DNA Polymerase III,*
    - *DNA Polymerase I,*
    - *DNA Gyrase (Topoisomerase II),*
    - *Initiator protein (DnaA),*
    - *SSB proteins,*
    - *Sliding Clamp (β subunit of DNA Pol III), Tus protein*),
2. Enzymes and Proteins associated with Eukaryotic DNA replication –

- *Origin Replication Complex (ORC),*
- *Cdc6 and Cdt1,*
- *Minichromosome maintenance (MCM) proteins,*
- *DNA Helicase,*
- *DNA Polymerase α (Pol α),*
- *DNA Polymerase δ (Pol δ),*
- *DNA Polymerase ε (Pol ε),*
- *CMG Helicase Complex (Cdc45-MCM-GINS),*
- *Replication Protein A,*
- *Proliferating Cell Nuclear Antigen (PCNA),*
- *Replication Factor C (RFC),*
- *DNA Ligase I,*
- *Flap Endonuclease 1 (FEN1),*
- *Dna2 and RNase H,*
- *Topoisomerases I and II, Telomerases*),

3. Mechanism of DNA replication in Prokaryotes and Eukaryotes (*Initiation, Elongation and Termination*),
4. Semiconservative replication, Theta (θ) replication and Rolling Circle model for circular DNA replication.

UNIT III: Transcription (07 Hours)

1. Structure and function of Prokaryotic genes –
    - *Promoter,*
    - *Coding sequence/Operons,*
    - *Terminator region*
2. Structure and function of Eukaryotic genes –
    - *Promoter and Enhancer,*
    - *Exons and Introns,*
    - *Termination region*,
3. Enzymes and Proteins involved in Transcription of Prokaryotic genes
    - *RNA Polymerase (α, β, β', ω, σ subunits),*
    - *Catabolite Activation Proteins (CAP),*
    - *Rho (ρ) protein*)
4. Enzymes and Proteins involved in Transcription of Eukaryotic genes
    - *RNA polymerase I, II and III,*
    - *General transcription factors (TFIID, TFIIB, TFIIE, TFIIF, and TFIIH),*
    - *Specific Transcription factors (Activators and Repressors),*
    - *TATA-Binding Protein (TBP)*),
5. The process of transcription in Prokaryotes –
    - *Initiation (Closed, Open and Tertiary Complex),*
    - *Elongation*
    - *Termination (Rho independent and dependent)*)
6. The process of transcription in Eukaryotes –
    - *Initiation,*
    - *Elongation,*
    - *Termination*,
7. RNA polymerases and transcription factors in plants,

8. Eukaryotic mRNA processing
    - *5' Methyl Capping,*
    - *3' Polyadenylation,*
    - *Splicing*.

UNIT IV: Translation (08 Hours)

1. Genetic code –
    - *Triplate nature,*
    - *Characteristics,*
    - *Wobble Hypothesis*,
2. Ribosomes
    - *Structure (small and large subunits)*
    - *Types in Prokaryotes (70s) and Eukaryotes (80s),*
    - *Plant specific features*,
3. Enzymes and proteins involved in Prokaryotic mRNA translations -
    - *Initiation Factors (IF1, IF2, IF3),*
    - *Elongation Factors (EF-Tu, EF-Ts, EF-G),*
    - *Peptidyl Transferase,*
    - *Release Factors (RF1, RF2, RF3)*)
4. Enzymes and proteins involved in Eukaryotic mRNA translations –
    - *Aminoacyl t-RNA synthetases,*
    - *Eukaryotic Initiation factors (eIFs),*
    - *Elongation Factors (EF1α, EF2),*
    - *Release Factor (eRF1)*),
5. Mechanism of Translation (protein synthesis) in Prokaryotes –
    - *Activation of Amino acids,*
    - *Formation of Aminoacyl-tRNA complex,*
    - *Initiation, Elongation and Termination of Polypeptide chain formation*.
6. Mechanism of Translation (protein synthesis) in Eukaryotes
    - *Activation of Amino acids,*
    - *Formation of Aminoacyl-tRNA complex,*
    - *Initiation, Elongation and Termination of Polypeptide chain formation*.

Suggested Laboratory Exercises: (Any 10 Exercise representing all the four units)

1. To study structure of DNA double helix using model/chart/photograph/ppt/video.
2. To study structures of different types of DNA using models /charts / photographs /ppt /video.
3. To study structure of different types of RNA using models / charts / photographs /ppt /video.
4. Extraction and quantification of DNA/RNA from local plant species.
5. Agarose gel electrophoresis and assessment of nucleic acid quality.
6. To estimate isolated DNA content by Diphenyl amine reagent method.
7. To prepare LB medium for culturing Bacteria.
8. To study Bacterial culture methods (streak plate and pour plate methods).
9. To isolate and quantify Plasmid DNA.
10. To study organization of eukaryotic chromatin using model /chart /photograph /ppt / video.
11. To study DNA replication mechanisms (Rolling circle, Theta replication and semi-conservative replication) through models/charts/photographs/ppt/video.

12. Survey/report on local plant genome diversity.
13. Isolation and analysis of total RNA from indigenous plant tissues.
14. Protein extraction and quantification from local seeds/leaves.
15. To study table of Genetic Code and find amino acid sequence from mRNA codons.
16. To study mechanism of transcription in prokaryotes using model/charts/photographs/ppt/video.
17. To study mechanism of transcription in eukaryotes using model /charts/photographs/ppt/video.
18. To study mechanism of eukaryotic mRNA processing (5' capping, 3'tailing and splicing) using model/chart/photographs/ppt/video.
19. To study mechanism of translation in prokaryotes using model/charts/photographs/ppt/video.
20. To study mechanism of translation in eukaryotes using model /charts /photographs/ppt/video.
21. Demonstration of in vitro translation (virtual/simulation if facilities are limited).

References:

Textbooks

- Biochemistry & Molecular Biology of Plants (2nd edition) edited by Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones. American Society of Plant Biologists/Wiley-Blackwell, 2015.This is a highly acclaimed, comprehensive reference, meticulously organized with over 1,000 illustrations and covering cell structure, gene expression, signal transduction, and plant-environment interactions.
- Plant Biochemistry and Molecular Biology (2nd edition) edited by Peter J. Lea & Richard C. Leegood. Wiley, updated edition.Covers molecular biology in a plant context, with updated chapters on metabolic and regulatory pathways.
- The Molecular Life of Plants by Russell L. Jones, Helen Ougham, Howard Thomas, Susan Waaland. Wiley-Blackwell/ASPB.An accessible, integrated introduction to plant molecular biology, offering a "seed-to-seed" life cycle approach.
- Molecular Plant Biology: A Practical Approach, Vol. 1-2 edited by P.M. Gilmartin & C. Bowler. Oxford University Press, 2002.Focuses on laboratory techniques and protocols, including gene isolation, mutagenesis, and plant transformation.
- Molecular Biology of the Gene (5th edition, general molecular biology) by James D. Watson et al. Pearson/Addison Wesley. While not plant-specific, this classic provides essential molecular biology foundations with relevance to plants.
- Molecular Cell Biology (Lodish et al.), recent editions.Comprehensive molecular and cellular processes, including gene regulation and signaling applicable to plant systems.

Reference Books

- Plant Molecular Genetics by S. Chakraborty & P.K. Borua. Scientific Publishers Focused on genetic engineering, molecular markers, and crop improvement strategies.
- A Textbook of Biotechnology by R.C. Dubey. S. Chand Publishing.Includes sections on molecular biology techniques and plant genetic transformation.

Research Papers & Review Articles

- Plant Molecular Biology (Springer): International peer-reviewed journal dedicated to molecular aspects of plant biology.Includes research articles, reviews, and methodological advancements.
- Annual Review of Plant Biology: Publishes review articles summarizing recent advances in plant molecular and cellular biology.
- The Plant Cell (ASPB), Plant Physiology (ASPB), Trends in Plant Science (Elsevier): Leading journals featuring high-impact papers and reviews on gene expression, genome editing, regulatory networks, and molecular responses to environmental cues.

Articles & Digital Content

- Biochemistry & Molecular Biology of Plants Companion Website (by ASPB/Wiley): Includes digital illustrations, PowerPoint slides, and teaching resources corresponding to the textbook.
- MIT OpenCourseWare and NPTEL Modules: Offer video lectures and notes on plant molecular biology, including genomics, gene expression, and transgenic technology.
- Plant Science ebooks and digital databases from Elsevier and Springer platforms provide direct access to current plant molecular biology research and textbooks.
- Institutional repositories and open-access resources such as PubMed Central, Plant Molecular Biology

Reporter (Springer), and preprint servers for up-to-date research.

- https://makautexam.net/aicte_details/Syllabus/BScMOLB/AllSem.pdf
- https://www.caluniv.ac.in/ccf-ug/files/MB-CSR-73.pdf
- https://makautwb.ac.in/syllabus/B.Sc(MolecularBiology)_Syllabus.pdf
- h t t p s:/ / w w w.a u j o d h p u r.a c.in / p u blic / p d f / S ylla b u s - D E P A R T M E N T O F M O L E C U L A R BIO L O G YA N D BIO T E C H N O L O G Y(U G , P G - a n d - P h D).p d f

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Major Elective (DSE-I) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 505

Ethnobotany, Ethnomedicine and Phytochemistry - I

Credits: 02 **Hours: 30**

UNIT I: Introduction to Ethnobotany and Ethnomedicine

Basic Principles: Definition, scope, and interdisciplinary nature of ethnobotany and ethnomedicine, Relationship between plants and indigenous/traditional cultures, Historical development and relevance in the modern context. Major ethnic groups and their lifestyles with respect to plant uses.**Categories of plant uses:** food, medicine, rituals, and miscellaneous.

Recent Advancements: Integration of ethnobotany with modern scientific approaches, Role of ethnobotanical research in bioprospecting and drug discovery, Intellectual Property Rights (IPR), biopiracy issues, and preservation of traditional knowledge.

UNIT II: Medicinal Plants and Their Ethnomedicinal Uses

Basic Principles: Introduction to medicinal plants (active phytochemicals and their therapeutic roles), Preparation and types of traditional medicines (decoctions, infusions, poultices), Categories of ethnomedicinal plants used for common ailments, Role of ethnomedicine in primary healthcare.

Recent Advancements: Phytochemical screening techniques and bioassays (antimicrobial, antioxidant activities), Ethnopharmacology and validation of traditional medicines using modern lab methods, Development of herbal drugs and commercial herbal products.

UNIT III: Ethnobotanical Research Methods and Conservation

Basic Principles: Methods of ethnobotanical research (field surveys, interviews, data recording), Classification and identification techniques for ethnobotanical specimens, Ethical considerations in ethnobotanical research, Importance of conservation of ethnobotanical and medicinal plant resources.

Recent Advancements: Use of GIS and digital tools in ethnobotanical documentation, Community-based conservation and participatory approaches, Role of ethnobotany in biodiversity conservation and sustainable use.

UNIT IV: Contemporary Issues and Applications in Ethnobotany and Ethnomedicine

Basic Principles: Role of ethnobotany and ethnomedicine in modern drug discovery and healthcare, Intellectual property rights (IPR), benefit sharing, and traditional knowledge protection, Impact of globalization and cultural changes on traditional knowledge systems, Sustainable utilization and ethical harvesting of ethnobotanical resources.

Recent Advancements: Advances in ethno-genomics and metabolomics in medicinal plant research, Patenting of herbal drugs and regulation of herbal products, Integration of traditional knowledge with modern medicine and biotechnology.

Suggested Laboratory Exercises:

1. Survey and documentation of local ethnobotanical plants.
2. Preparation of herbarium sheets from collected local medicinal plants.
3. Case studies on local ethnic groups' plant knowledge.
4. Extraction and qualitative phytochemical tests of local medicinal plants.
5. Testing antimicrobial or antioxidant activity of extracts from indigenous plants.

6. Documentation and analysis of traditional herbal formulations from local sources.
7. Field trips to local tribal settlements or forests for plant survey.
8. Data collection and preparation of Peoples' Biodiversity Registers (PBR).
9. Preparation of ethnobotanical reports focusing on local plant use and conservation.
10. Patent search exercises related to herbal and ethnomedicinal products.
11. Testing of biochemical parameters and effectiveness of local herbal extracts.
12. Socio-economic impact study of local ethnobotanical resources and products.

References:

Textbooks

- Martinez, J.L., Muñoz-Acevedo, A., & Rai, M. (2018). Ethnobotany: Application of Medicinal Plants. CRC Press. This comprehensive text incorporates case studies from various global regions, focusing on ethnomedicinal plants, traditional uses, and applications in healthcare.
- Trivedi, P.C., & Sharma, N. (2011). Text Book of Ethnobotany. Indian Books and Periodicals. A syllabus-aligned Indian textbook introducing ethnobotanical concepts, traditional plant use, and field methodologies.
- Sarkar, B. (Ed.). (2024). The Basic Handbook of Indian Ethnobotany and Traditional Medicine Vol. 1. Updated guide including both classical and regional ethnomedicinal practices.

Reference Books

- Pullaiah, T., Krishnamurthy, K.V., & Bahadur, B. (Eds.). Ethnobotany of India: Five-Volume Series. Routledge/CRC Press. This authoritative series explores human-plant relationships, medicinal plants, regional diversity, and ethnomedicine across India, providing in-depth regional and thematic studies.
- Harshberger, J.W. An International Textbook on Medicinal Plants of India: An Ethnobotanical Research. IIP Publications. Covers the evolution, scope, and modern application of ethnobotanical research, including databases and bioinformatics for ethnomedicine.
- Economic Botany, Ethnomedicine and Phytochemistry. (2023). Follows common university syllabi, integrating economic aspects, phytochemistry, and ethnomedicine with a focus on practical applications.

Research Papers, Articles, and Journals

- Hydrobiology and Medicinal Plants of the Indian Subcontinent. Eds. Srivastava, R.K. (2021). This collection contains over 150 peer-reviewed papers on ethnobotany, medicinal plants, and economic plants in the Indian subcontinent.
- Phytochemical and ethnomedicinal research articles are frequently published in journals such as Journal of Ethnopharmacology, Journal of Ethnobiology and Ethnomedicine, and Ethnobotany Research & Applications. Access recent reviews and specific case studies via databases like PubMed and Google Scholar.
- Regional studies, such as those focusing on Arunachal Pradesh, indigenous knowledge, and medicinal plants of tribal groups, are covered in recent chapters in edited volumes and open-access journals.

Digital and Open-access Resources

- Uttarakhand Open University, Ethnobotany - Syllabus-oriented course module (MSCBOT-608): Comprehensive, freely available PDF covering fundamentals, research methods, medico-ethnobotany, ethnomedicines, conservation, and regulatory aspects.
- TNAU Agritech Portal – Section on Medicinal Plants and Ethnobotany: Notes, practical exercises, ethnomedicinal uses and management protocols tailored for university courses.
- Online library guides, such as the Sacramento State University "Books - Ethnoecology, Ethnobotany & Medicinal Plants" page, curate eBooks and references on global ethnobotany, indigenous plant use, and pharmacological applications.

Recommended Syllabus-aligned Indian Resources

- Pandey, B.P. "Botany for Degree Students": Includes chapters on Ethnobotany and Ethnomedicine.
- Vardhman Mahaveer Open University, Kota: Open-source ethnobotany units and practical manuals for Indian undergraduate and postgraduate syllabi.
- Digital databases such as NAPRALERT, AYURBASE, and others referenced in recent ethnobotanical literature provide curated data on medicinal plant use, chemical constituents, and traditional applications.
- https://www.mangalkotegovtcollege.org/wp-content/uploads/2024/08/Botany-Ethnobotany-22-23.pdf
- https://uou.ac.in/sites/default/files/slm/MSCBOT-608.pdf
- https://www.keralauniversity.ac.in/downloads/MSc_Botany_with_specialization_in_Ethno_Botany_and_Ethno_Pharmacology1605678105.pdf

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Major Elective (DSE-I) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 505

Mycology and Plant Pathology - I

Unit- I:

1. Introduction, Definition, Objectives, Mycological institute in India (IARI and VINSTROM), progress and status of mycology in India.
2. General Characteristics and classification of fungi by G. C. Ainsworth, 1973 (outline only).
3. Characteristic of Mastigomycotina, Ascomycotina, Zygomycotina, Basidiomycotina and Deuteromycotina.

Unit- II:

1. Chemical composition of fungal cell wall and its functions.
2. Characteristics of fungi spores, types of spores based on spore production structure, function and motility.
3. General variations in fungi Heterokaryopsis, Parasexuality, Homothallism and Heterothallism.

Unit- III

1. Role of fungi in industrial Mycology, scope & their utility.
2. Industrial application of fungal enzymes – protease, cellulase & invertase.
3. Production of alcoholic beverages, antibiotics, organic acids, alkaloids & ergot by using fungi.

Unit – IV

1. Production of secondary metabolites by using fungi.
2. Role of fungi in agriculture and forestry & conservation of germplasm.
3. Cultivation of fungi for food – Mushrooms, mycoproteins & mycofoods & importance of medical mycology.

Laboratory Exercises: -

Make use of permanent micro-preparation, temporary mounts, transparencies, photographs, charts etc.

1. Principles & working of tools, Equipment's and other requirements in the Mycology & Plant Pathology laboratory
2. General Mycological laboratory procedures.
3. Sterilization Processes viz. Moist heat, Dry heat, Chemical and Radiation.
4. To study the Preparation of Potato Dextrose Agar (PDA).
5. Pouring of Nutrient Media into Petri dishes and Slant preparation.
6. Isolation of soil borne Fungi by dilution method.
7. Isolation of air borne Fungi on nutrient media.
8. Preparation of pure culture of Fungi and its identification.
9. Measurement of fungal growth by linear determination.
10. Study of locally available Mushrooms.
11. To study and demonstrate Mushroom culture technique.
12. To study the construction of Mushroom culture unit.
13. To test the sensitivity of microorganism against antibiotics.

Suggested Readings:

1. Introductory Mycology – C. J. Alexopolus & C. W. Mims
2. A text book of fungi – B. R. Vashishta

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Major Elective (DSE-I) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 505

Paleobotany - I

UNIT – I:

I. INTRODUCTION

Concepts of Palaeontology and Paleobotany; Baron Georges Cuvier (Father of Palaeontology), Professor Birbal Sahni (Father of Indian Paleobotany); The Birbal Sahni Institute of Paleobotany, Lucknow; Wadadham Fossil Park, Sironcha; Scope and Objectives of Paleobotany

UNIT – II:

II. FOSSILS AND FOSSILIZATION

Fossils; Process and conditions for Fossilization; Nature of the specimen undergoing Fossilization; Events Before, During and After Fossilization; Theories of Fossilization; Types of Fossils; Kinds of Fossils

UNIT – III:

III. TECHNIQUES FOR FOSSIL STUDY

1. Methods of Study Petrifications- Ground Thin Sections, Film or Peel Method, Microtomy, X-Ray Radiography Technique, µ-Computed Tomography.
2. Methods of Study Compressios- Maceration Techniques, Transfer Technique, Excavation Technique.

Form Genera; Nomenclature of Fossil Plants; Calculation of Age of Fossil

UNIT – IV:

IV. CLASSIFICATION OF FOSSIL PLANTS

Classification of Fossil Plants; Fossils of - Algae, Fungi, Bryophytes, Ptridophytes-*Rhynia*, Gymnosperms-*Cycadeoidea,* Angiosperms-*Enigmocarpon* Fruit *and Sahnianthus* Flower

Laboratory Exercises:

1. Study of different types of Fossils.
2. Study of different kinds of Fossils.
3. Study any Petrified fossil material by Peeling Technique.
4. Study Compression fossil material by MacerationTechnique.
5. Study of fossilAlgae material from permanent slides.
6. Study of fossilFungi material from permanent slides.
7. Study of fossilBryophytes material from permanent slides.
8. Study of fossilPteridophytes material from permanent slides.
9. Study of fossilGymnosperms material from and permanent slides.
10. Study of fossilAngiosperms material from permanent slides.
11. Study of Fossil Localities of Chandrapur District.
12. Study of Wadadham Fossil Parks, Sironcha
13. Visit to Palaeobotanical Institutes, Localities and Fossil Parks.

Suggested Readings:

1. Stewart, W.N. and Rothwell G.W. (1993): Palaeobotany and the Evolution ofPlants, Cambridge University Press.
2. Foster A.S. & Gifford F.M. (1967): Comparative morphology of vascular plants,Freeman Publishers, San Fransisco.
3. Eames, A.J. (1974): Morphology of Vascular Plants- lower groups, Tata Mc-Graw Hill publishing Co., New Delhi.
4. Arnold, C.A. (1947): Introduction to Palaeobotany, Mc-Graw Hill Book Co. Inc., New York and London.
5. Kubitzki K. (1990): The families and genera of vascular plants Pteridophytes and Gymnosperms, Springer Verlag, New York
6. Agashe, S.N. (1995): Palaeobotany, Oxford & IBH, New Delhi.
7. Biswas, C & Johri, B.N. (2004): The Gymnosperms, Narosa Publishing House, New Delhi.
8. Coulter J.M. & Chamberlain C.J. (1978): Morphology of Gymnosperms, Central Book Depot, Allahabad.
9. Kakkar, R.K. and Kakkar, B.R. (1995): The Gymnosperms (Fossils & Living), Central Publishing House, Allahabad.
10. Sharma O.P. (2002) Gymnosperms, Pragati Prakashan, Meerut.
11. Siddiqui, K.A. (2002): Elements of Palaeobotany, Kitab Mahal, Allahabad.
12. Bhatnagar, S.P. and Moitra A. (1996): Gymnosperms, New Age International Pvt. Ltd., New Delhi.
13. Singh, H. (1978): Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X, Gebryder, Bortragear, Berlin.
14. Pant, D.D. (2003): *Cycas* and allied Cycadophytes, BSIP, Publications.
15. Bierhorst D.W. (1971): Morphology of vascular plants McMillan, New York.
16. Thomas, B.A. & Spicer R.A. (1987): The Evolution and Palaeobiology of land plants. Discordies Press, Fortland, USA.
17. Spicer, R.A. & Thomas, B.A. (1986): Systematic and taxonomic approaches in Palaeobotany.Systematic Association Special Volume.
18. Chamberlain C.J. (1986): Gymnosperms, structure and Evolution, CBS publishers and distributors, New Delhi. On line Journals available on UGC -VSAT

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Major Elective (DSE-I) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 505
Biodiversity Conservation - I

UNIT I: INTRODUCTION TO BIODIVERSITY CONSERVATION

1. **Definition, Concept, Importance and Scope of Biodiversity**
    i) Definition of biodiversity
    ii) Concept and components of biodiversity
    iii) Values & Importance: Ecological value, Economic value, Social and cultural value Ethical, aesthetic and scientific values, Ecosystem services
    iv) Scope of biodiversity studies
2. **Levels of Biodiversity**
    i) Genetic diversity
    ii) Species diversity
    iii) Ecosystem diversity
3. **Major Zones of Distribution of Biodiversity**
    i) Climatic zones of the Earth: Tropical, Temperate and Polar
    ii) Phytogeographical regions of India

4 Biodiversity Hotspots

i) Concept and criteria of biodiversity hotspots
ii) Global biodiversity hotspots
iii) Biodiversity hotspots of India
- Western Ghats
- Himalaya

iv) Significance of hotspots in biodiversity conservation

5. **Threats to Biodiversity**
    i) Habitat loss
    ii) Fragmentation
    iii) Overexploitation
    iv) Invasive alien species
    v) Pollution
    vi) Climate change
    vii) Poaching and illegal wildlife trade
6. **Impact of loss of Biodiversity**
    i) Ecological impact
    ii) Economic impact
    iii) Social impact

UNIT II: BIODIVERSITY ASSESSMENT AND MONITORING TECHNIQUES

1. **Biodiversity Assessment**
    i) Objectives and significance of plant biodiversity assessment
    ii) Floristic surveys and vegetation analysis
2. **Sampling Methods for Biodiversity Assessment**
    i) Quadrat method
    ii) Transect methods (Line and Belt Transects)
    iii) Sampling of forest sand grasslands

3. Vegetation Analysis and Biodiversity Indices

i) Frequency, density and abundance
ii) Basal area and Importance Value Index (IVI)
iii) Species richness and species evenness
iv) Simpson's Diversity Index
v) Interpretation and applications of biodiversity indices

4. Techniques in Plant Biodiversity Monitoring

i) Remote Sensing and GIS in vegetation mapping
ii) GPS applications in plant biodiversity surveys
iii) People's Biodiversity Registers (PBRs)
iv) Community participation in plant conservation
v) Citizen science initiatives for plant biodiversity documentation

5. Molecular Tools in Plant Biodiversity Studies

i) DNA barcoding of plants
ii) Molecular markers (RAPD, ISSR, SSR—overview)
iii) Applications of molecular tools in plant conservation

UNIT III: PRINCIPLES AND STRATEGIES OF BIODIVERSITY CONSERVATION

1. Principles of Biodiversity Conservation

i) Objectives and principles of biodiversity conservation
ii) Sustainable use of biodiversity

2. In Situ Conservation

i) Concept, objectives and significance
ii) Protected Area Network
- National Parks
- Wildlife Sanctuaries
- Biosphere Reserves
- Conservation Reserves and Community Reserves

3. Ex Situ Conservation

i) Concept, objectives and significance
ii) Botanical gardens
iii) Arboreta
iv) Seed banks
v) Field gene banks
vi) Cryopreservation
vii) Captive breeding

4. Conservation Genetics and Priorities Ethics

i) Role of genetics in species conservation
ii) Conservation prioritization
iii) Environmental ethics and biodiversity ethics
iv) Community participation and indigenous knowledge
v) Sustainable development and conservation

5. Species-Based Conservation

i) Keystone species
ii) Indicator species
iii) Umbrella species
iv) Flagship species

UNIT IV: RECENT DEVELOPMENTS AND GLOBAL INITIATIVES

1. **International Conventions and Organizations**
    i) Convention on Biological Diversity (CBD)
    ii) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
    iii) Ramsar Convention on Wetlands
    iv) International Union for Conservation of Nature (IUCN) and the IUCN Red List
2. **Ecological Restoration and Habitat Management**
    i) Concept and objectives of ecological restoration
    ii) Habitat restoration and rehabilitation
    iii) Reforestation and afforestation
    iv) Restoration of degraded ecosystems
3. **Role of Biotechnology in Biodiversity Conservation**
    i) Tissue culture and micropropagation
    ii) Cryopreservation
    iii) DNA banking
    iv) Genetic rescue (introductory concept)
    v) Cloning and assisted reproductive technologies (overview)
4. **Sustainable Use of Biodiversity**
    i) Principles of sustainable utilization
    ii) Agro-biodiversity and its conservation
    iii) Bioprospecting and benefit sharing
5. **Emerging Challenges in Biodiversity Conservation**
    i) Climate change and biodiversity loss
    ii) Habitat degradation and ecosystem resilience
    iii) Invasive alien species

SUGGESTED LABORATORY EXERCISES

UNIT I: INTRODUCTION TO BIODIVERSITY CONSERVATION

1) Documentation of Biodiversity Components and Their Values.
2) Estimation of Species Diversity Using Diversity Indices.
3) Documentation of Global and Indian Biodiversity Hotspots.
4) Demonstration of Major Climatic and Phytogeographical Zones.
5) Assessment and Documentation of Threats and Impacts on Biodiversity.

List of Spotting

1) Biodiversity Hotspot Map of India
2) Western Ghats Biodiversity Hotspot (Map/Photograph)
3) IUCN Threatened Plant Species (Photographs/Specimens)
4) Invasive Alien Plant Species – *Lantana camara* / *Parthenium hysterophorus*
5) Different Levels of Biodiversity (Genetic, Species and Ecosystem Diversity Charts)

UNIT II: BIODIVERSITY ASSESSMENT AND MONITORING TECHNIQUES

1) Documentation of Plant Biodiversity through Floristic Survey and Vegetation Analysis.
2) Estimation of Plant Biodiversity Using Quadrat and Transect Sampling Methods.
3) Estimation of Vegetation Parameters and Biodiversity Indices.
4) Demonstration of GPS, Remote Sensing, GIS and People's Biodiversity Register (PBR) in Plant Biodiversity Monitoring.
5) Demonstration of Molecular Tools Used in Plant Biodiversity Studies.

List of Spotting

1) Quadrat Sampling Frame
2) Line Transect and Belt Transect Demonstration Setup

3) Herbarium Specimen/Floristic Documentation Sheet
4) GPS Device/Mobile GPS Application for Biodiversity Survey
5) DNA Barcode / Molecular Marker Profiles (RAPD, ISSR, SSR)

UNIT III: PRINCIPLES AND STRATEGIES OF BIODIVERSITY CONSERVATION

1) Documentation of Principles and Objectives of Biodiversity Conservation.
2) Documentation and Demonstration of In Situ Conservation Methods.
3) Documentation and Demonstration of Ex Situ Conservation Methods.
4) Demonstration of Conservation Genetics, Environmental Ethics and Community Participation.
5) Documentation and Identification of Species-Based Conservation Categories.

List of Spotting

1) National Park / Wildlife Sanctuary Map or Photograph
2) Biosphere Reserve Model/Map
3) Botanical Garden / Seed Bank / Field Gene Bank Specimen
4) Captive Breeding Programme Photograph
5) Keystone, Indicator, Umbrella and Flagship Species Examples

UNIT IV: RECENT DEVELOPMENTS AND GLOBAL INITIATIVES

1) Documentation of International Conventions and Organizations for Biodiversity Conservation.
2) Demonstration of Ecological Restoration and Habitat Management Techniques.
3) Demonstration of Biotechnological Tools Used in Biodiversity Conservation.
4) Documentation of Sustainable Use of Biodiversity and Agro-biodiversity.
5) Assessment and Documentation of Emerging Challenges in Biodiversity Conservation.

List of Spotting

1) Convention on Biological Diversity (CBD) Document/Logo
2) IUCN Red List Categories Chart
3) Plant Tissue Culture and Micropropagation Setup
4) Cryopreservation Technique Diagram
5) Ecological Restoration / Afforestation Model or Photograph

Suggested Readings:

1) Agarwal, K. C. (2002). *Biodiversity and environment*. New Delhi, India: APH Publishing Corporation.
2) Begon, M., Townsend, C. R., & Harper, J. L. (2006). *Ecology: From individuals to ecosystems* (4th ed.). Oxford, UK: Blackwell Publishing.
3) Bonham, C. D. (2013). *Measurements for terrestrial vegetation* (2nd ed.). Chichester, UK: Wiley-Blackwell.
4) Campbell, N. A., Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R. B. (2018). *Campbell biology* (11th ed.). New York, NY: Pearson.
5) Gaston, K. J., & Spicer, J. I. (2004). *Biodiversity: An introduction* (2nd ed.). Oxford, UK: Blackwell Publishing.
6) Groom, M. J., Meffe, G. K., & Carroll, C. R. (2006). *Principles of conservation biology* (3rd ed.). Sunderland, MA: Sinauer Associates.
7) Hunter, M. L., & Gibbs, J. P. (2007). *Fundamentals of conservation biology* (3rd ed.). Oxford, UK: Blackwell Publishing.
8) Krishnamurthy, K. V. (2003). *An advanced textbook of biodiversity: Principles and practice*. New Delhi, India: Oxford & IBH Publishing Co. Pvt. Ltd.
9) Magurran, A. E. (2004). *Measuring biological diversity*. Oxford, UK: Blackwell Publishing.
10) Mueller-Dombois, D., & Ellenberg, H. (1974). *Aims and methods of vegetation ecology*. New York, NY: John Wiley & Sons.
11) Primack, R. B. (2014). *Essentials of conservation biology* (6th ed.). Sunderland, MA: Sinauer Associates.
12) Primack, R. B., & Sher, A. A. (2016). *An introduction to conservation biology*. Sunderland, MA: Sinauer Associates.
13) Sharma, P. D. (2021). *Ecology and environment* (14th ed.). Meerut, India: Rastogi Publications.
14) Singh, J. S., Singh, S. P., & Gupta, S. R. (2014). *Ecology, environmental science and conservation*. New Delhi, India: S. Chand Publishing.
15) Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). *Conservation biology for all*. Oxford, UK: Oxford University Press.
16) Sutherland, W. J. (2006). *Ecological census techniques: A handbook* (2nd ed.). Cambridge, UK: Cambridge University Press.

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
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Course Code – USCBOT 505
Reproductive Biology of Angiosperms – I

Credits: 02 **Hours: 30**

Unit I

Introduction and scope of Reproductive Biology: Reproduction in angiosperms; Types of reproduction, Vegetative reproduction (natural and artificial) and sexual reproduction, The Life cycle of an Angiosperm.

History : contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison.

Embryological Features of Taxonomic Importance, Role of embryology in taxonomy

Unit II

Reproductive development: Development of Flower in Angiosperms, Basic structure of Flower, floral organ differentiation, flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

The flower: A modified shoot, parts of flower (types and modification in Bracts, Calyx. Corolla, Androecium, Cohesion of stamens, Adhesion of stamens, Gynoecium, Placentation)

Types of Flowers (On the basis of sex organs present, symmetry, Position of floral leaves and presence of Accessory whorls). Chasmogamous and Cleistogamous flowers. Floral formula and floral diagram.

Unit III

Inflorescence: Types of inflorescence, Special types and its significance.

Structure of anther and pollen- Sturcture of anther lobe, microsporogenesis and development of male gametophyte, pollen morphology and NPC system. Pollen viability, causes for loss of pollen viability.

Abnormal features : Pseudomonads, polyads, massulae, pollinia.

Unit IV

Structure and types of ovules, megasporogenesis and development of female gametophyte, Types of embryo sacs (monosporic, bisporic and tetrasporic), organization and ultrastructure of mature embryo sac. (details of Polygonum type)

Pollination: Pollination types, mechanisms and adaptations, floral attractants and rewards.

Incompatibility: self-incompatibility, mechanism of self-compatibility, importance of self-compatibility.

Suggested Laboratory Exercises: (Any 10)

1. To study and identify different types of inflorescences.
2. To study and identify different types of Flower
3. To study and identify parts of Flower - Androecium: i) Anther filament relationship ii) Cohesion of stamens and iii) Adhesion of stamens iv) Length of filament. (as per theory syllabus).
4. To study different placentation types. (Slides/photographs/fresh material).
5. Study of mitosis and meiosis and identification of various stages. (slides/photographs/fresh material).
6. To study various vegetative reproductive organs.
7. To study various artificial vegetative propagation 1. Root cutting 2. Stem cutting 3. Leaf cutting

8. To study artificial grafting method and its types.
9. To study floral diagram and floral formula of various flowers (Locally available)
10. To study Structure of anther, microsporogenesis and pollen grain (slides/photographs/fresh material).
11. Interpretation of electron micrographs (SEM, TEM) of pollen (slides/photographs/fresh material).
12. Preparation of permanent slides using micro-technique: Section cutting and processing for staining.
13. Study of pollen morphology (polarity, symmetry, shape, size, aperture) using acetolysis method (slides/photographs/fresh material)
14. To study different types of pollination and adaptations. (slides/photographs/fresh material).
15. Calculation of percentage germination in different media using hanging drop and or sitting drop method.

Suggested Readings

Asker S. 1979, Progress in apomixis research. Hereditas 91, 231-240.

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Donald McEwan Alexander and William J. Lewis. 2009. Series Grafting and Budding Edition 2. A Practical Guide for Fruit and Nut Plants and Ornamentals LANDLINKS PRESS.

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Gardner Frank Easter 1932. The Vegetative Propagation of Plants. University of Maryland, Agricultural Experiment Station.

Gifford, E. M. and Foster A. S. 1988. Morphology and Evolution of Vascualr Plants. W.H. Freeman & Company, New York.

Herr, J.M. (1984). Embryology and Taxonomy. In: Johri, B.M. (eds) Embryology of Angiosperms. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-69302-1_14

https://courseware.cutm.ac.in/courses/reproductive-biology-of-angiosperm

https://royalsocietypublishing.org/doi/pdf/10.1098/rsbm.1999.0080

HU Shi-Yi. Centenary on S.G.Nawaschin's Discovery of Double Fertilization: Retrospects and Prospects[J]. J Integr Plant Biol., 1998, 40(1).1-13.

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Johri, B. M., Srivastava, P. S., & Singh, N. (2001). Reproductive Biology of Angiosperms. Reproductive Biology of Plants, 237–272.

Johri, B. M., Srivastava, P. S., & Singh, N. (2001). Reproductive Biology of Angiosperms. Reproductive Biology of Plants, 237–272.

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Gondwana University, Gadchiroli

Theory Question Paper Pattern

B. Sc. SEMESTER – V BOTANY (Major Paper DSE - I)

Time: 03 Hours **Total Marks: 40**

Note: 1) All questions are compulsory and carry equal marks.
2) Draw well labelled diagram wherever necessary, but NOT necessary for Q. No. 5

Question 1. Write in detail **4 M x 2 = 08 M**

a) Unit – I
b) Unit – I

OR

c) Unit – II
d) Unit – II

Question 2. Write in detail **4 M x 2 = 08 M**

a) Unit – III
b) Unit – III

OR

c) Unit – IV
d) Unit – IV

Question 3. Write in short **2 M x 4 = 08M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit –I

OR

e) Unit –II
f) Unit – II
g) Unit – II
h) Unit – II

Question 4. Write in short **2 M x 4 = 08 M**

a) Unit – III
b) Unit – III
c) Unit – III
d) Unit –III

OR

e) Unit –IV
f) Unit – IV
g) Unit – IV
h) Unit – IV

Question 5. Write answers to any Eight questions in one or two lines only. **1 M x 8 = 08 M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit – II
e) Unit – II
f) Unit – II
g) Unit – III
h) Unit – III
i) Unit – III
j) Unit – IV
k) Unit – IV
l) Unit – IV

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SEMESTER –V (Level – 05.5)
Practical Examination – Botany (Major DSE - I)

(Based on Theory Major DSE-I)
Course Code – USCBOT 506

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] based on exercise from Unit I	05 M
Que. 2: Any one Exercise [B] based on exercise from Unit II	05 M
Que. 3: Any one Exercise [C] based on exercise from Unit III	05 M
Que. 4: Any one Exercise [D] based on exercise from Unit IV	05 M
Que. 5: SPOTTINGS SPOT – E :From Unit I SPOT – F :From Unit II SPOT – G :From Unit III SPOT – H: From Unit IV	04 M
Q 6: Submission of duly certified Practical Record	02 M
Q. 7 Submission of Institution Visit Report	02 M
Q 8: Viva-Voce.	02 M

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Minor Paper – III (2 Credits; 30 hours) (UA-40 + CA-10)
Course Code – USCMEEB 05

Economic Botany

Credits: 04 **Hours: 60**

UNIT I: Origin, Scope & Principles of Economic Botany (15 Hours)
Basic Principles: Definition, scope, and historical development of Economic Botany. Classification of plants based on economic use (food, fiber, medicine, etc.). Domestication and centers of origin of cultivated plants. Major food crops: cereals (rice, wheat), millets, pulses.
Recent Advancements: Biotechnological improvement in staple food plants (e.g., transgenic rice, biofortified crops). Advances in crop productivity and resource-efficient varieties.

UNIT II: Commercial and Industrial Plants (15 Hours)
Basic Principles: Sources and uses of plant fibers (Cotton, Jute, Hemp). Edible oils (Mustard, Groundnut, Sesame), Beverages (Tea, Coffee, Palash, Senna), and Sugars. Timber, Rubber, Resins, and other industrial raw materials.
Recent Advancements: Advances in fiber technology (e.g., improved Cotton varieties, eco-friendly processing). New industrial applications: bio-based plastics, phyto-remediation.

UNIT III: Medicinal, Spices, Aromatic & Plantation Crops (15 Hours)
Basic Principles: Introduction to medicinal plants (active compounds, sources, uses, pharmacognosy basics), Spices and condiments (botany, cultivation, and uses), Plantation crops (Nilgiri, Teak).
Recent Advancements: Ethnobotanical approaches and plant-based drug discovery. Advances in cultivation and processing of high-value medicinal/spice crops.

UNIT IV:Contemporary Issues & Sustainable Utilization (15 Hours)
Basic Principles: Role of plants in environmental sustainability and rural development. Non-timber forest products, biofuels, and fodder plants. Conservation and sustainable management of plant resources.
Recent Advancements: Sustainable harvesting techniques and community-based resource management. Recent developments in bio-energy and plant-based green technologies.

Suggested Laboratory and Field Exercises:

1. Morphological and anatomical study of grains/pulses used locally.
2. Estimation of nutritional parameters (Carbohydrates, Proteins, Fats and Vitamins) in staple food crops though biochemical tests.
3. Survey/report on indigenous food crops and their socio-economic impact.
4. Identification and analysis of local fiber crops.
5. Demonstration/Extraction and qualitative analysis of oil/essential oil/biofuel from local crops.
6. Field visit or case study on local plant-product-based industry.
7. Morphological characteristics and microscopic analysis of local medicinal plants.
8. Morphological characteristics and microscopic analysis of local spice, condiments and beverage plants.
9. Extraction and phytochemical screening from regional medicinal plants.
10. Preparation of herbarium sheets or traditional knowledge documentation on Ethnobotany.
11. Survey and mapping of locally exploited wild/NTFP plants.

12. Socio-economic impact assessment of plant-based rural enterprises.

13. Case study/project on local agro-ecosystem or resource management practices.

REFERENCES

Textbooks

- Economic Botany, 5th Edition by S.L. Kochhar. Cambridge University Press, 2016. Widely regarded as a seminal text, covering plant domestication, crop origins and uses, ethnobotany, major economic plant groups (food, beverages, fibres, medicines, timber, etc.), and biodiversity conservation. Heavily illustrated; updated content for undergraduates and postgraduates.
- Economic Botany by B.P. Pandey. S. Chand Publishing, multiple editions. A popular Indian textbook, suitable for undergraduate and competitive examinations. Describes major economic plants, their cultivation, processing, and uses in detail.
- Economic Botany by Albert F. Hill. Surjeet Publications. Classic reference discussing useful plants and plant products globally, appropriate for advanced undergraduate courses.
- Economic Botany: Plant Resources & Economic Botany – A Comprehensive Textbook by Dr. Kalyan Das, Mahaveer Publications. Focuses on plant resources and their economic value, offering Indian and global perspectives.
- Economic Botany: An Introduction for Undergraduates (2024). Comprehensive and current, covering crop origins, global food and industrial uses, ethnobotany, biodiversity, and commercial applications. Useful for both science and applied courses.

Reference Books

- A Textbook of Economic Botany by S.L. Kochhar (multiple editions).
- Textbook of Economic Botany by R.W. Schery. Wiley Eastern, 1972.
- Plants for Man by R.W. Schery. Prentice-Hall, 1972.

Research Papers & Review Articles

- Economic Botany (journal, Springer): Peer-reviewed journal publishing research on the relationship between plants and people globally, including new uses, domestication, and ethnobotany.
- Journal of Ethnopharmacology (Elsevier): Valuable for research on medicinal plants and traditional knowledge in economic botany.
- Selected review articles in Annual Review of Plant Biology and Economic Botany (journal).

Articles & Digital Content

- Cambridge University Press – Supplementary references and reading lists included in "Economic Botany, A Comprehensive Study".
- Economic Botany course materials from major universities (e.g., MIT OpenCourseWare, lecture notes and video content on useful plants, plant resources, and ethnobotany).
- Digital Commons (Humboldt State University): General reference lists and open-access publications on economic botany.
- Online lectures and practical guides from institutions like NPTEL (India), focusing on economic plant species, their uses, and industrial applications.
- https://botany.uok.edu.in/Files/bdcfcf70-294a-4c43-95ed-70caf685f3b2/Alert/UG_Botany_5th_Semester_CBCS_70d1b6eb-ae04-48a0-9fea-f92857a69937.docx
- https://www.cbpbu.ac.in/userfiles/file/2023/Syllabus_NEP2023/Botany.pdf
- https://cottonuniversity.ac.in/storage/uploads/syllabus/54b5eee97e244ba50239831d90ef9573.pdf

Gondwana University, Gadchiroli

Theory Question Paper Pattern

B. Sc. SEMESTER – V BOTANY (Minor Paper III – Economic Botany)

Time: 03 Hours **Total Marks: 40**

Note: 1) All questions are compulsory and carry equal marks.
2) Draw well labeled diagram wherever necessary, but NOT necessary for Q. No. 5

Question 1. Write in detail **04 M x 02 = 08 M**

a) Unit – I
b) Unit – I

OR

c) Unit – II
d) Unit – II

Question 2. Write in detail **04 M x 02 = 08 M**

a) Unit – III
b) Unit – III

OR

c) Unit – IV
d) Unit – IV

Question 3. Write in short **02 M x 04 = 08M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit –I

OR

e) Unit –II
f) Unit – II
g) Unit – II
h) Unit – II

Question 4. Write in short **02 M x 04 = 08M**

a) Unit – III
b) Unit – III
c) Unit – III
d) Unit –III

OR

e) Unit –IV
f) Unit – IV
g) Unit – IV
h) Unit – IV

Question 5. Write answers to any ten questions in one or two lines only. **1 M x 08 = 08 M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit – II
e) Unit – II
f) Unit – II
g) Unit – III
h) Unit – III
i) Unit – III
j) Unit – IV
k) Unit – IV
l) Unit – IV

Practical Examination
B. Sc. SEMESTER – V (Level 05.5)
Subject – Botany (Minor)
(2 Credits; 60 hours) (UA-30 + CA 20)
Economic Botany
Course Code: USCMEEB 06

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] based on Food crops 04 M

Que. 2: Any one Exercise [B] based on Oil crops 04 M

Que. 3: Any one Exercise [C] based on Fibre crops 04 M

Que. 4: Any one Exercise [D] based on Medicinal plants 04 M

Que. 5: SPOTTINGS 06 M

SPOT – E : Spices and Condiments
SPOT – F : Timber
SPOT – G : Transgenic Crop
SPOT – H: NTFP
SPOT – I : Gum/Resin
SPOT – J: Beverage

Q 6: Submission of duly certified Classical/Virtual Herbarium sheet on Ethnobotany 04 M

Q 7: Submission of duly certified Practical Record 02 M

Q 8: Viva-Voce. 02 M

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Vocational Skill Course (2 Credits; 60 hours) (UA-30+CA-20)
Course Code – VSC

Option I: Plant Growth Medium

Unit I:**Fundamentals of Plant Growth Medium**

Definition and importance of plant growth media in agriculture and horticulture.
Types of growth media: natural soil, soilless media (Compost, Peat –Peat Moss, Peat Humus, Cocopeat, Shredded Bark, Leaf Mould, Vermiculite, Perlite), andinert substrates (Sand).
Key physical and chemical properties: texture, porosity, water-holding capacity, aeration,nutrient availability, pH, electrical conductivity (EC).
Role of growth media in seed germination, root development, and overall plant growth.
Overview of local soils in eastern Vidarbha (black cotton soil, lateritic soil) and theirsuitability as growth media.
Challenges associated with local soils and need for alternative growth media.

Unit II:**Recent Advancements and Technology in Growth Media**

Novel soilless culture techniques: hydroponics, aquaponics, aeroponics.
Use of biochar, compost, and organic waste (rice husks, farmyard manure) as sustainablemedia amendments.
Integration of nanomaterials and microbial inoculants for enhanced nutrient delivery.
Advances in media sterilization and preparation techniques to minimize pathogens.
Local innovations in utilizing agro-waste for media development.
Environmental and economic aspects of choosing growth media in Vidarbha context.

Laboratory Exercises

1. Collection and preparation of local soil samples for use as growth media.
2. Preparation and sterilization of common growth media (soil-based and soilless).
3. Measurement of media physico-chemical properties: pH, EC, moisture content, bulk density.
4. Comparative germination and growth experiments using different media.
5. Setting up and managing a simple hydroponic or container system with alternative media.
6. Documentation and analysis of plant growth performance in different growth media.
7. Field visits to local nurseries/agriculture centers demonstrating media selection and use.
8. Constraints of eastern Vidarbha soils: water retention, fertility, salinity, and degradation.
9. Sustainable sourcing of growth media: use of local agro-residues and waste materials.
10. Impact of climatic factors and soil conditions on media performance.
11. Economic considerations in media selection for small and marginal farmers.
12. Case studies of successful adaptation of growth media and soilless cultivation in Vidarbha/Maharashtra/India.
13. Awareness of government schemes supporting sustainable nursery and media development.

References:

- Taiz, L., & Zeiger, E. (2018). Plant Physiology and Development (6th Ed.).
- Marschner, P. (2012). Marschner's Mineral Nutrition of Higher Plants.
- Reddy, S.R., & Ramu, R. (2016). Introduction to Agronomy. Kalyani Publishers.
- Kokate, C.K. (2017). Pharmacognosy (for phytochemical aspects relevant in growth media).
- Hilty, J. et al. (2021). "Plant growth: the What, the How, and the Why".
- Carneiro, J.S.S. et al. (2022). Studies on soilless substrates and their agronomic impact. Indian Journal of Soil Science, Indian Journal of Agricultural Sciences – articles focused onsoil and media management in Vidarbha.
- Recent Advances in hydroponic culture and media sterilization (Defence Life Science Journal, 2022).
- NCERT chapters on Plant Growth and Development.
- ICAR e-Krishi Shiksha portal on nursery and growth media management.
- Sant Gadge Baba Amravati University syllabi and resources on Nursery and Soil Management.
- Maharashtra State Agriculture Department and PDKV Akola online bulletins relevant to localsoil and nursery media.
- ScienceDirect, PubMed, and MDPI Plants for updated research on plant growth media.

Gondwana University

Semester – V (Level 05.5)

Practical Examination Scheme for Vocational Skill Course (VSC)

OPTION – I

PLANT GROWTH MEDIUM

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Identify and comment on soil type [A] based on given Physico-chemical properties 05 M

Que. 2: Identify Plant Growth media [B] based on compositions 05 M

Que. 3: Enlist locally available Agro-residue/waste material sources [C] for media preparation 05 M

Que. 4: Write Protocol for Preparation and Sterilization [D] of growth media. 05 M

Que. 5: SPOTTINGS 06 M

SPOT – E : Tools for Media Preparation (Item/Photograph)
SPOT – F : Instrument/Equipment for Media Preparation (Item/Photograph)
SPOT – G : Commercial Plant Growth Medium (Item/Photograph)

Q 6: Submission of duly certified Practical Record 02 M

Q 7: Viva-Voce. 02 M

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
Vocational Skill Course (2 Credits; 60 hours) (UA-30+CA-20)
Course Code – VSC

Option II: Modern Farming Techniques

Unit I: **Basic Principles of Modern Farming**

Introduction to modern farming: Definition, scope, and significance, Overview of traditional vs. modern farming approaches.

Soil health fundamentals: Soil types of eastern Vidarbha, fertility, and management practices.

Water management: Irrigation methods suited to eastern Vidarbha's climate and waterscarcity issues.

Crop selection and crop rotation: Matching crops to local agro-climatic zones, Introduction to conservation agriculture, climate-resilient and sustainable farming concepts.

Challenges in Vidarbha's farming systems: soil degradation, drought, pest pressures.

Unit II: **Recent Advancements in Modern Farming**

Soilless farming systems: Hydroponics, Aeroponics, Vertical farming, and their practicalapplicability.

Protected cultivation techniques: Polyhouses, Greenhouses, and Shade nets.

Use of smart farming technologies: Sensors for soil moisture, drone surveillance, GPS/GIS formonitoring.

Precision agriculture: Variable rate nutrient and water management, sensor-guidedfertigation, Integration of organic farming and biofertilizers with modern practices, Biotechnology tools in crop improvement relevant to regional crops.

Laboratory Exercises

14. Collection and preparation of local soil samples for use as growth media.
15. Preparation and sterilization of common growth media (soil-based and soilless).
16. Measurement of media physico-chemical properties: pH, EC, moisture content, bulk density.
17. Seed testing: germination percentage, vigor tests. Seed bed preparation and sowing techniques.
18. Setting up and managing a simple hydroponic or container system with alternative media.
19. Setting up simple aeroponic systems using locally available media.
20. Documentation and analysis of plant growth performance in different modern farming techniques. .
21. Identification and use of fertilizers, organic manure, and biofertilizers for Hydroponics and Aeroponics.
22. Field visits to local nurseries/agriculture centers demonstrating Modern Farming Techniques.
23. Case studies of successful adaptation of soilless cultivation in Vidarbha/Maharashtra/India.
24. Awareness of government schemes supporting Modern Farming Techniques.

References:

- Taiz, L., & Zeiger, E. (2018). Plant Physiology and Development (6th Ed.).
- Marschner, P. (2012). Marschner's Mineral Nutrition of Higher Plants.
- Reddy, S.R., & Ramu, R. (2016). Introduction to Agronomy. Kalyani Publishers.
- Kokate, C.K. (2017). Pharmacognosy (for phytochemical aspects relevant in growth media).
- Hilty, J. et al. (2021). "Plant growth: the What, the How, and the Why".
- Carneiro, J.S.S. et al. (2022). Studies on soilless substrates and their agronomic impact. Indian Journal of Soil Science, Indian Journal of Agricultural Sciences – articles focused onsoil and media management in Vidarbha.
- Recent Advances in hydroponic culture and media sterilization (Defence Life Science Journal, 2022).
- NCERT chapters on Plant Growth and Development.
- ICAR e-Krishi Shiksha portal on nursery and growth media management.
- Sant Gadge Baba Amravati University syllabi and resources on Nursery and Soil Management.
- Maharashtra State Agriculture Department and PDKV Akola online bulletins relevant to local soil and nursery media.
- ScienceDirect, PubMed, and MDPI Plants for updated research on plant growth media.
- Sant Gadge Baba Amravati University: M.Sc. (Botany)and B.Sc. (Agriculture) syllabirelevant to modern farming practices.
- ICAR e-Krishi Shiksha portal and digital agriculture initiatives of the Government of India.
- ScienceDirect, PubMed, and MDPI Plants for updated research reviews on farminginnovations.
- Maharashtra State Agriculture Department and PDKV Akola's online resources on soil andwater management in Vidarbha.

Gondwana University
Semester – V (Level 05.5)
Practical Examination Scheme for Vocational Skill Course (VSC)
OPTION – II
MODERN FARMING TECHNIQUES

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Identify and comment on soil type [A] based on given Physico-chemical properties 05 M

Que. 2: Write protocol for performing seed testing [B] 05 M

Que. 3: Enlist requirements[C] for setting up Hydroponics/Aquaponic/Aeroponics 05 M

Que. 4: Write Protocol for Preparation and Sterilization [D] of growth media for Aquaponic/Aeroponics 05 M

Que. 5: SPOTTINGS 06 M

SPOT – E : Tools for Hydroponics/Aquaponic/Aeroponics Media Measurement (Item/Photograph)
SPOT – F : Instrument/Equipment for Hydroponics/Aquaponic/Aeroponics Media Preparation (Item/Photograph)
SPOT – G : Commercial Plant Growth Medium (Item/Photograph)

Q 6: Submission of duly certified Practical Record 02 M

Q 7: Viva-Voce. 02 M

B. Sc. Botany (NEP2020)

SEMESTER – V (Level 05.5)

Field Project/Community Engagement Practice Based on Major Subjects (2 Credits; 60 hours) (UA-30 +CA-20)

Course Code – FP/CEP

A detailed guideline for conduction and evaluation of the Field Project (FP)/ Community Engagement Practice (CEP) will be provided by the University separately.

B. Sc. Botany (NEP2020)
SEMESTER – V (Level 05.5)
IKS SS (2 Credits; 30 hours) (UA-40 + CA-10)
Core Course: Indian Knowledge System in Botany – I
Total Hours: 30 **Credits: 2**

Unit I: Foundations of Indian Knowledge System in Plant Sciences **Allotted Hours: 8**

Topic	Subtopics	Teaching Scope	Hours
1. Introduction to Indian Knowledge System (IKS)	Concept, scope, and significance of IKS	- Define IKS and its interdisciplinary nature	03
	IKS in the context of modern plant science	- Discuss how IKS complements modern Botany	
	Relevance of IKS under NEP 2020	- Link IKS to biodiversity, sustainability, and traditional practices	
2. Ancient Indian Texts on Plant Sciences	Rigveda ऋग्वेद, Yajurveda, Atharvaveda अथर्ववेद	- Identify key texts and their botanical content	03
	Charaka Samhita चरक संहिता, **Sushruta Samhita** सुश्रुत संहिता	- Highlight plant-related verses and classifications (**Rasa** रस, **Virya** वीर्य, **Vipaka** विपाक).	
	Vrikshayurveda वृक्षायुर्वेद (**Parasara** पराशर), **Brihat Samhita** बृहत्संहिता (**Varahamihira** वराहमिहिर)	-Introduce the concept of **Vanaspati** वनस्पती, **Vanaspata** वनस्पता**/Vrksa** वृक्ष **, Oshadhi** ओषधी, **Virudh** विरुद्/**Valli** वल्ली etc. from texts	
3. Historical Development of Plant Sciences in India	Pre-Vedic to medieval period	- Timeline of botanical knowledge evolution	03
	Philosophical Foundations	- **Panchamahabhuta** पंचमहाभूते **theory** (five elements: Prithvi पृथ्वी, Ap आप, Tejas तेज, Vayu वायू, Akasha आकाश) and plant biology - **Tridosha** त्रिदोष **framework** applied to plant health. - Concept of **Antah-Sanjna** अंतःसंज्ञा (latent consciousness in plants). - Integration of spiritual principles into agricultural practices (**Agnihotra** अग्निहोत्र, **Yajna** यज्ञ).	
	Transition from traditional to modern Botany in India	- Integration with global botanical developments	

Unit II: Ancient Indian Plant Classification and Taxonomy **Allotted Hours: 8**

Topic	Subtopics	Teaching Scope	Hours
1. Traditional Concepts of Plant Classification in Ancient texts	**Ayurvedic Samhitas** आयुर्वेदिक संहिता and **Nighantus** निघंटू	- Explain Charaka's, (Rasa रस, Virya वीर्य, Vipaka विपाक). - **Nighantus** निघंटू**:** Specialized botanical glossaries and lexicons (e.g., **Bhavaprakasha Nighantu** भावप्रकाश	03

		निघंटू, **Dhanvantari Nighantu** धन्वंतरी निघंटू) tracking medicinal plants and locations.	
	Phanerogamia–Cryptogamia analogy in ancient texts	- Use examples from **Rigveda** ऋग्वेद and later texts (***Puṣpiṇī*** पुष्पिणी/flowering plants, ***Apuṣpā*** अपुष्प/non-flowering plants, **Phalinī** फलिनी/with fruit, **Aphalā** अफला**/** without fruit)	
2. Terminology and Nomenclature in Ancient Texts	Sanskrit terms for plant parts (Parna, Puspa, Paraga, etc.)	- Introduce Sanskrit botanical vocabulary	
	Morphological descriptors in Sanskrit	- Show how plants were named by colour, shape, taste Systematic structuring based on **morphology** (e.g., **Tripatrika** त्रिपत्रिका for three-leaflets *Aegle* sp., *Butea* sp., *Trigonella* sp. **Dvipatrika** द्विपत्रिका *Mimosa sp*.**, Panchatrika** पंचत्रिका *Bombax sp.***, Shushka-patra** शुष्क-पत्र *Tinospora sp*.**, Kantaka-patra** कंटक-पत्र *Acacia catechu***, Peeta-pushpi** पीतपुष्पी *Sphaeranthus indicus***, Rakta-pushpi** रक्तपुष्पी *Erythrina variegata***, Shveta-pushpi** श्वेत-पुष्पी *Ocimum sanctum***, Kshuraka** क्षुरक *Saccharum spontaneum*). - **Functional property-based naming: Katu-patra** कटु-पत्र (spicy leaves), Tikta तिक्त (bitter), Madhura मधुर (sweet), **Kashaya** कषाय **(**Astringent**), Amla** आम्ल **(**Sour), **Lavana** लवण **(**Salty**), Sheeta-virya** शीत-वीर्य **(**Cooling potency), **Ushna-virya** उष्ण-वीर्य **(**Heating potency**), Vatahara** वातहर **(**Vata-reducing**), Pittahara** पित्तहर **(**Pitta-reducing**), Kaphahara** कफहर **(**Kapha-reducing**), Jantughna** जंतूघ्न **(**Antimicrobial**), Rasayana** रसायन **(**Rejuvenative), **Balya** बल्य **(**Strength-promoting), **Medhya** मेध्य **(**Brain-enhancing). - Comparison with binomial nomenclature (Linnaean system)	
	Early naming conventions based on characters	- Link to modern descriptive taxonomy	

Unit III: Traditional Plant Morphology and Physiology in IKS Allotted Hours: 8

Topic	Subtopics	Teaching Scope	Hours
1. Ancient Concepts	- Root, stem, leaf,	- Map Sanskrit terms to modern structures	

of Plant Morphology	flower, fruit descriptions	**Mula** मूळ (Root), **Skandha** स्कंध **/Kand** कांड (Trunk/Stem), **Shakh** शाख (Branch), **Patra** पत्र (Leaf), **Parnika** पर्णिका(Leaflet), **Puspa** पुष्प (Flower), **Vṛnta** वृंत (Petiole/Pedicel/Stalk of fruit), **Mukulam** मुकुलम (Bud), ***Stabakā / Stabakaḥ*** स्तबक *(*bunch/ bouquet), **Phal** फळ (fruit), Beej बीज (seed), **Tus** तूस (Husk), **Ankur** अंकुर (Sprout), **Kshir** क्षीर (Latex/Sap)	
	- Inflorescence types in Sanskrit texts	- Discuss ancient understanding of modifications ***Mañjarī*** मंजरी or ***Vallarī*** वल्लरी*, Types (**Saśākhā** सशाखा and **Aśākhā** अशाखा)*	
	- Morphological variations and adaptations	- Relate to ecological adaptations **Habitat-based naming**: Vindhyaja विंध्यज, Malayaja मलयज, Dravidi द्राविडी, **Samudra-ja** समुद्रज, Upavana उपवन (Marshy), Maru मरू (arid), Jala जल (aquatic), **Ghata** घाट **(**Hill/mountain slope**)**, **Kshetra** क्षेत्र (Cultivated), plants. ***Parājīvī*** परजीवी *(Parasite), **Uparirūḍha*** उपरिरूढ/ *Aśrayī* आश्रयी *(Epiphytic)*	
2. Plant Growth and Development in IKS	- Concepts of sprouting, flowering, fruiting	- Explain seasonal cycles (**Vasanta** वसंत**, Grishma** ग्रीष्म**, Parjanya** पर्जन्य etc.) - Discuss phenology in traditional agriculture	
	Seasonal influences on plant growth (Ritu ऋतू based)	- Connect to modern plant physiology	
	Traditional understanding of life cycles	- Connect to modern plant physiology	
3. Plant Physiology in IKS	**Padapa** पादप	- Discuss concept; -Nutrient transport mechanisms documented in ancient texts.	
	External Senses	Plants perceive heat, sound, and light; adapt growth directions accordingly.	
	Photosynthesis concepts in Vedic literature	Explain Surya-Tejas सूर्य-तेज connection	
3. Traditional Plant–Environment Interactions	Habitat-based classification	- Use examples from texts on habitat preferences - ***Jala-ja*** जल-ज**/*Apya*** आप्य *(*Aquatic/Water dwelling,- ***Paṅka-ja*** पंक-ज**/*Kardama-ja*** कर्दम-ज *(Marshy/Muddy wetland,* - **Sthala-ja** स्थळज (Terrestrial/Land-growing), - **Vana-ja** वन-ज (Forest/Wild growing), - **Kṣetra-ja** क्षेत्र-ज (Cultivated), - ***Giri-ja*** गिरि-ज**/*Parvata-ja*** पर्वत-ज *(Mountain/Hill growing),* - **Uṣṇa-deśa-ja** उष्ण-देश-ज (arid	

		or warm region growing), ***Sac-chāya*** स-छाया/***Chāyā-priya*** छायाप्रिय *(*growing under cover or shade*),* **Deva-vana** देव-वन (Sacred grove / ritual site)	
	Soil, water, and climate influences	- Discuss traditional agro-ecological practices; Organic manuring, Panchagavya, Use of Indigenous seeds, Water management, Crop rotation and mixed cropping, Natural pest management.	
	Ecological wisdom in ancient texts	ऋग्वेद - "माता भूमिः पुत्रो'हं पृथिव्याः" छान्दोग्य उपनिषद - "तत्त्वमसि" Concept of "वसुधैव कुटुंबकम्", Concept of "पंचमहाभूत" - Link to modern ecological concepts	

Unit IV: Traditional Uses of Plants and Early Applications Allotted Hours: 6

Topic	**Subtopics**	**Teaching Scope**	Hours
1. Plants in Rituals, Culture, and Daily Life	Sacred plants, flowers, leaves, and woods in rituals	- Identify commonly used ritual plants; Aśvattha अश्वत्थ (*Ficus religiosa*), Bilva बिल्व (*Aegle marmelos*), Tulasī तुळस (*Ocimum* sp.), Durvā दुर्वा (*Cynodon dactylon*), *Akapatra* अकपत्र *(Musa sp.),* Padma पद्म (*Nemumbo* sp.), Amra आम्र (*Mangifera* sp.), Shami शमी (*Prosopis cineraria*) Supari सुपारी (*Areca* sp.), *Tambūla* तांबूल / *Pān* पान *(Piper betel),* Haridrāहरिद्रा (*Curcuma* sp.), Kuśaकुश (Sacred grass), *Samidha* समिधा twigs (*Ficus religiosa, F. benghalensis, F. racemosa, Butea monosperma, M. indica, P. cineraria, Syzygium cumini*) Shwet-Chandana श्वेत-चंदन (*Santalum album*), Rakta-Chandana रक्तचंदन (*Pterocarpus santalinus*) - Discuss spiritual and cultural roles	
	Symbolism and cultural significance	- Connect to conservation of sacred species	
2. Traditional Food Plants and Nutrition	Cereals, pulses, vegetables, fruits	- Discuss staple food plants in Vedic/medieval India - *Yava* जव (Barley); *Vrīhi* व्रीहि (Rice), *Godhūma* गोधूम(Wheat), *Kangu* कांगू, *Syāmāka* श्यामक, *Vārī* वरी (Millets), *Mudga* मुद्ग (Green gram), *Māṣa* मास(Black gram), *Cana* चना (Horse gram), śāka शाक (Vegetables), *Kūṣmāṇḍa* कूष्मांड *(Pumpkin)*, *Vṛntāka* वृन्ताक *(Eggplant)*, *Palāka* पालक *(Spinach)*, *Mūlaka* मुळक*(Raddish)*	
	Dietetic classification in Ayurveda	- Explain Ayurvedic dietetic principles: Prakṛti प्रकृती (Nature of Food), Sanyoga संयोग	

		(Combination), *Rāśi* राशी / *Mātrā* मात्रा *(Quantity), Deśa* देश (Place), *Kāla* काळ (Time), *Upayoga-Saṃsthā* उपयोग-संस्था(Rules of eating), Samskāra संस्कार (Cooking method), Upayoktā उपयोक्ता(Consumer) - Broader Ayurvedic food theory: *Rasa* रस (six food tastes- Madhura मधुर, Amla आम्ल, Lavaṇa लवण, Kaṭu कटू, Tikta तिक्त, Kaṣāya कषाय) and their effects on *Dosas* दोष(Vat वात, Pitta पित्त and Kafa कफ). - Food categories: *Sūkadhānya* शूकधान्य (Grains), *Sāka* शाक (Vegetables), *Phala* फळ (fruits), *Dugdha-varga* दुग्ध-वर्ग (Milk products), *Māṃsa* मांस (Meat), *Jala* जल (Water) and *Kṛtānna* कृतान्न (prepared food).	
	Nutritional wisdom in ancient texts	- Link to modern food science	
3. Early Plant-Based Technologies	Use of plants in dye, fibre, oil, and fuel	-**Dye plants:** *Nili* निली (Indigo), *Manjishtha* मंजिष्ठा(Madder), *Haridrā* हरिद्रा(Turmeric), *Kusumbha* कुसुंभा (Safflower), *Harītakī* हरीतकी, *Amalakī* आमलकी, *Bibhitaka* बिभीतक *(Myrobalan/Tannin source)* -**Fiber plants:** Kārpāsa कार्पास (Cotton), Patta पट्टा(Jute), Bhaṅga भांग (Hemp), Uma उमा (Flax), Kadali-tantu कदली-तंतू (Banana fibre), Nārikela-ja tantu नारिकेल-ज तंतू (Coconut fibre). -**Oil plants:** Tila तीळ (Sesame), S*arṣapa* सर्षप/ R*ai* राई *(Mustard), Atasi* अतसी/ *Umā* उमा *(Flax/Linseed), Eranda* एरंड *(Castor),* Nārikela नारिकेल (Coconut). **- Fuel plants:** *Firewood* (*Samidhā* समिधा, *Kāṣṭha* काष्ठ*),* Sacred wood *(Palāśa* पळस, *Khadira* खदिर, *Aśvattha* अश्वत्थ, *Bilva* बिल्व*),* Dried grass (*Tṛuṇa* तृण), Dung-cake with plant matter (Gomaya गोमय/Karisa करिसा), Bamboo / reed biomass (*Vaṃśa* वंश). - **Highlight plant-based technologies:** Dyeing, Spinning and weaving, Oil extraction, Fuel and fire	
	Traditional crafts and materials	- Discuss eco-friendly practices; Pottery, Carpentry, Basketry / Matting, Weaving, Dyeing, Ritual vessels.	
	Sustainability in ancient plant use	- Connect to modern bio-materials	

Suggested Readings and References – Semester V

Primary Texts

1. Bhagavatagnivesha. (1975). *Charaka Samhita*.
2. Shastri, M. N. (2009). *Manavakyana and Ancient Indian Botanical Knowledge*.
3. Lal, B. B. (2005). *The Vedic Heritage: Plant Names and Classifications in Rigveda*.
4. Amarmuni. (1987). *Bhagvati Sutra*.
5. Kaushal, S. (Ed.). *Vrikshayurveda of Parasara* (Sanskrit with translation).
6. Surapala. **Vrikshayurveda** (c. 1000 AD) - Translation and commentary on plant life science
7. Jain, S.K. (1995). **Manual of Ethnobotany**. Scientific Publishers, Jodhpur.
8. Mishra, L. (ed.) (2009). **Indian Knowledge System: Tradition and Modernity**. Aakar Books, Delhi.
9. Khare, C.P. (2004). **Indian Herbal Remedies: Rational Western Therapy, Ayurvedic and Other Traditional Usage, Botany**. Springer, Berlin.

Secondary Books & Articles

6. Singh, U. (2008). *A History of Ancient and Medieval India*. (Botanical sections)
7. Jain, S. C. (1991). *Traditional Botany in India*.
8. TRAPEV (2022). "Traditional Botanical Knowledge in Ancient India." *Journal of Traditional and Folk Plants*.
9. NCERT / UGC–NEP documents on IKS integration in Science.
10. National Informatics Centre (NIC) – "Indian Knowledge Systems: Plant Science" portal.
11. Trivedi, P.C. (2006). **Medicinal Plants: Ethnobotanical Approach**. Agrobios, India.
12. Gandey, S. (2010). **Indian Ethnobotanical Perspectives**. Anamaya Publishers, New Delhi.
13. Purohit, S.V. & Vyas, S.P. (2008). **Medicinal Plant Cultivation: A Scientific Approach** (2nd ed.). Agrobios, India.
14. Rahi, M.L. (2021). **Indian Ethnobotany - Recent Trends**. Scientific Publishers, Jodhpur.
15. Panda, U.C. & Panda, B.K. (2013). **Indian Ethnobotany – An Introduction**. Scientific Publishers.

Ancient Text References:

1. **Rigveda** - Plant categories and ritual properties
2. **Atharvaveda** - Therapeutic applications and medicinal plant uses
3. **Charaka Samhita** - Medicinal plants and bio-energetic properties
4. **Sushruta Samhita** - Surgical and medicinal plant applications
5. **Bhavaprakasha Nighantu** - Botanical glossary of medicinal plants
6. **Dhanvantari Nighantu** - Medicinal plant lexicon

Online Resources:

1. **Traditional Knowledge Digital Library (TKDL):** https://tkdl.in
2. **National Medicinal Plants Board:** https://nmpb.nic.in
3. **Botanical Survey of India:** https://bsi.gov.in
4. **Ministry of AYUSH:** https://ayush.gov.in
5. **SWAYAM IKS Courses:** https://onlinecourses.swayam2.ac.in
6. **INDICA Courses - Vrikshayurveda:** https://indica.courses
7. https://smtsalunkabairaut.com/assets/notice-board/notice-21-07-2024-2.pdf
8. https://www.cuhimachal.ac.in/admin/assets/uploads/iqacArchive/Learning Outcomes/Course learning outcomes along with content for Dept. of Plant Science (Botany).pdf
9. https://iksindia.org/images/iks-course-2/4_Wellness-&-Conservation_TDU_Dr-Subramanya-Kumar.pdf
10. https://bbmku.ac.in/storage/app/public/pdfs/Slo3fgZw5delx5YUbvTmn0lS6Nnil7qKKAUs4WVP.pdf
11. https://ngbv.ac.in/data/2728BOT_NEP_2025-26_Final.pdf
12. https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/faculty-of-science-and-technology/sem-i-ii-ay-25-26/bsc-in-botany-sem-i-ii.pdf
13. https://www.sus.ac.in/uploads/bos/Syllabus 2024 25/Sci/UG/BSc I Botany 03042025.pdf
14. https://cdnbbsr.s3waas.gov.in/s39ed9328611fe3f45b3cce8ffe386ee97/uploads/2025/03/202503181256578029.pdf
15. https://sansad.in/getFile/annex/263/AU513.pdf
16. https://ranchiuniversity.ac.in/phocadownload/UGNEP2025/IKS for Sem I, III, IV_& SA for Sem II_2025 onwards.pdf
17. https://www.scribd.com/document/813159839/IKS-Generic-Syllabus-NEP-UG-Sem1-2-Revised-23-08
18. https://iar.ac.in/wp-content/uploads/2023/09/GoG-SOPforImplofNEP2020Gujarat.pdf
19. https://ashimdutta.in/2025/07/05/integrating-indian-knowledge-systems-in-science-and-education-under-nep-2020/
20. https://www.suniv.ac.in/docs/NEP-2020-Botany-UG-syllabus.pdf
21. https://www.hnbgu.ac.in/sites/default/files/2024-02/Syllabus of B.Sc_. Botany as per NEP 2020.pdf
22. https://onlinecourses.swayam2.ac.in/nou25_ge95/preview
23. https://smtsalunkabairaut.com/assets/notice-board/notice-21-07-2024-2.pdf
24. https://sansad.in/getFile/annex/263/AU513.pdf
25. https://ranchiuniversity.ac.in/phocadownload/UGNEP2025/IKS for Sem I, III, IV_& SA for Sem II_2025 onwards.pdf
26. https://www.scribd.com/document/813159839/IKS-Generic-Syllabus-NEP-UG-Sem1-2-Revised-23-08
27. https://iar.ac.in/wp-content/uploads/2023/09/GoG-SOPforImplofNEP2020Gujarat.pdf
28. https://ashimdutta.in/2025/07/05/integrating-indian-knowledge-systems-in-science-and-education-under-nep-2020/
29. https://www.suniv.ac.in/docs/NEP-2020-Botany-UG-syllabus.pdf
30. https://www.hnbgu.ac.in/sites/default/files/2024-02/Syllabus of B.Sc_. Botany as per NEP 2020.pdf
31. https://onlinecourses.swayam2.ac.in/nou25_ge95/preview
32. https://www.cuhimachal.ac.in/admin/assets/uploads/iqacArchive/Learning Outcomes/Course learning outcomes along with content for Dept. of Plant Science (Botany).pdf
33. https://www.sus.ac.in/uploads/bos/Syllabus 2024 25/Sci/UG/BSc I Botany 03042025.pdf
34. https://cdnbbsr.s3waas.gov.in/s39ed9328611fe3f45b3cce8ffe386ee97/uploads/2025/03/202503181256578029.pdf
35. https://iksindia.org/images/iks-course-2/4_Wellness-&-Conservation_TDU_Dr-Subramanya-Kumar.pdf
36. https://bbmku.ac.in/storage/app/public/pdfs/Slo3fgZw5delx5YUbvTmn0lS6Nnil7qKKAUs4WVP.pdf
37. https://ngbv.ac.in/data/2728BOT_NEP_2025-26_Final.pdf
38. https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/faculty-of-science-and-technology/sem-i-ii-ay-25-26/bsc-in-botany-sem-i-ii.pdf
39. https://www.facebook.com/khalsacollegepatiala.edu/posts/invited-talk-on-the-indian-knowledge-system-and-national-education-policy-2020pr/1311713347620987/

Research Journals:

1. **Indian Journal of Traditional Knowledge (IJTK)** - CSIR Publication
2. **Journal of Ayurveda and Holistic Medicine**
3. **Ancient Science of Life** - Journal of Ayurveda
4. **Journal of Ethnopharmacology**
5. **International Journal of Research in Ayurveda and Pharmacy (IJRAP)**

Question Paper Pattern
B. Sc. Semester V
Subject: IKS in Botany – I

Time: 2 Hours | Maximum Marks : 40

Que 1. Short Answer Questions **04 Que. X 02 Marks = 08 Marks**
A) Unit I
B) Unit I
C) Unit I
D) Unit I

OR

Short Answer Questions
A) Unit II
B) Unit II
C) Unit II
D) Unit II

Que 2. Short Answer Questions **04 Que. X 02 Marks = 08 Marks**
A) Unit III
B) Unit III
C) Unit III
D) Unit III

OR

Short Answer Questions
A) Unit IV
B) Unit IV
C) Unit IV
D) Unit IV

Que 3. Multiple Choice Questions **08 Que. X 01 Mark = 08 Marks**
1) Unit I
2) Unit I
3) Unit I
4) Unit I
5) Unit I
6) Unit I
7) Unit I
8) Unit I

OR

Multiple Choice Questions
1) Unit II
2) Unit II
3) Unit II
4) Unit II
5) Unit II
6) Unit II
7) Unit II
8) Unit II

Que 4. Multiple Choice Questions **08 Que. X 01 Mark = 08 Marks**
1) Unit III
2) Unit III
3) Unit III
4) Unit III
5) Unit III
6) Unit III
7) Unit III
8) Unit III

OR

Multiple Choice Questions
1) Unit IV
2) Unit IV
3) Unit IV
4) Unit IV
5) Unit IV
6) Unit IV
7) Unit IV
8) Unit IV

Qu. 5 Answer in One-Two Sentences (Attempt any *Eight*) 08 Que. X 01 Mark = 08 Marks
a) From Unit I
b) From Unit I
c) From Unit I
d) From Unit II
e) From Unit II
f) From Unit II
g) From Unit III
h) From Unit III
i) From Unit III
j) From Unit IV
k) From Unit IV
l) From Unit IV

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Gondwana University, Gadchiroli
NEP 2020 U.G. PROGRAMME SESSION 2026-27
Faculty of Science and Technology
Programme Name - B.Sc. SemesterVI (Level-5.5)

Sr. No.	Course Category	Subject name	Total Credit	Teaching Scheme (Hrs)			Examination Scheme									Total Marks
							Theory					Practical				
				Theory	Practical	Total Hrs.	UA	CA	Total Mark	Min. Passing	Duration of Exam (Hrs.)	UA	CA	Total Mark	Min. Passing	
1	Major Subject (Core Subject)	Paper VII 2 credits Theory + 2 credits Practical **Plant Ecology**	04	02	04	06	40	10	50	20	03	30	20	50	25	100
		Paper VIII 2 credits Theory + 2 credits Practical **Plant Growth & Development**	04	02	04	06	40	10	50	20	03	30	20	50	25	100
2	Major Subject (Discipline Specific Elective)	Paper DSE II 2 credits Theory + 2 credits Practical Any one from Major Discipline Elective Subject Basket	04	02	04	06	40	10	50	20	03	30	20	50	25	100
3	Minor Subject (Core Subject)	Paper IV 2 credits Theory + 2 credits Practical **Medicinal Botany**	04	02	04	06	40	10	50	20	03	30	20	50	25	150
4	OJT/RP	Based on Major subjects (30 hrs/credit)	04	--	08	08						60	40	100	50	100
5	IKS SS	IKS in Botany - II	02	02	-	02	40	10	50	20	02	-	-	-	-	50
Total			22	10	24	34	200	50	250	100	14	180	120	300	150	550

Annexure – III

NEP2020 B. Sc. Botany Major

B. Sc. Semester VI

Basket for Discipline Specific Elective – II

Options	DSE – II Subjects
I	Molecular Biology and Plant Biotechnology – II
II	Ethnobotany, Ethnomedicine and Phytochemistry – II
III	Mycology and Plant Pathology – II
IV	Paleobotany – II
V	Biodiversity Conservation – II
VI	Reproductive Biology of Angiosperms - II

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Paper – VII (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 601

Plant Ecology

Credits: 02 **Hours: 30 Hours**

Unit I: **Basic Concepts and Scope of Plant Ecology**

Introduction: Definition, scope, and importance of Plant Ecology.

Levels of ecological study: Autecology, Synecology, and Ecosystem ecology.

Abiotic environmental factors and their influence on plants: Light, Temperature, Water, Soil

Biotic factors& their influence on plants: Plant-Plant, Plant-Animal, Plant-Microbe interactions.

Ecosystem structure and function.

Energy flow, nutrient cycling, and productivity concepts.

Study of region-specific plant-environment interactions and ecological challenges (e. g., local invasive species, habitat fragmentation, water scarcity effects on local flora).

Unit II: **Types and Classification of Plant Communities**

Concept of plant communities: types and characteristics

Classification and structure of plant communities: Physiognomic, Floristic, and Ecological classification.

Community attributes: Species composition, dominance, diversity indices.

Succession: Types, mechanisms, and models of succession Ecotones and Edge effects.

Study of local forests, grasslands, wetlands, and their community dynamics and conservation status.

Unit III: **Applications and Recent Advancements in Plant Ecology**

Role of Plant Ecology in conservation biology and ecosystem management. Restoration ecology and ecological rehabilitation.

Urban ecology and impact of urbanization on plant ecosystems. Climate change effects on plant distribution and phenology.

Use of remote sensing and GIS in plant ecological studies.

Recent molecular tools and ecological genomics in Plant Ecology research.

Climate resilience strategies for local crop and wild plant species, effects of pollution on local vegetation.

Unit IV: **Practical Applications and Experimental Plant Ecology**

Field methods: Quadrat sampling, transect methods, and vegetation analysis.

Population ecology: study of population density, frequency, and dispersion.

Measurement of ecological parameters: soil analysis, light intensity, and water potential measurement.

Laboratory studies on seed germination ecology and physiological responses to abiotic stresses.

Vegetation survey of local habitats, assessment of invasive species, and biodiversity documentation

Suggested Laboratory Exercises: (Any 10 Exercise representing all the four units)

1. Visit to nearby Aquatic Ecosystem (Pond/Lake/River/Estuary/Sea) and study its Abiotic and Biotic components.
   Visit nearby Terrestrial Ecosystem (Grassland/Farmland/Forest/Mountain) and study its Abiotic and Biotic components.
2. Autecology of hydrophytic species (e. g., *Phormidium* sp., *Chara* sp., *Hydrilla* sp., *Trapa* sp., *Nelumbo* sp., *Nymphaea* sp., *Ipomoea* sp., etc.).
3. Autecology of xerophytic species (e. g., *Casuarina* sp., *Acacia* sp., *Opuntia* sp., *Asparagus* sp., *Ruscus* sp., *Nerium* sp., etc.).
4. Autecology of epiphytic species (e. g., *Dendrobium* sp., *Eria* sp., *Phalenopsis* sp., *Vanda* sp., etc.).
5. Autecology of halophytic species (e. g., *Avicennia* sp., *Sonneratia* sp., *Bruguier* asp.,*Rhizophora* sp., etc.).
6. T*o study different methods of plant diversity study (Plot sampling, Transect sampling, Quadrat sampling, Remote sensing and Genetic analysis).*
7. To determine minimum size of quadrat for diversity study using species-area curve method.
8. To determine minimum number of quadrat required to plot for reliable diversity study using species-area curve method.
9. To study community by quadrat method by determining quantitative characters like frequency, density and abundance of different species in the community.
10. To determine Important Value index (IVI) of different species growing in the community.
11. To estimate population size by Mark and Recapture method.
12. To study inter and intra-specific interactions in the community.
13. Measurement and analysis of soil parameters (pH, texture, moisture content) from local sites.
14. Analysis of Physico-chemical characteristics of water collected from nearby reservoirs.
15. Seed germination experiments under variable environmental conditions (temperature, light, water).
16. Study of leaf water potential and stomatal behavior of local xerophytic or hydrophytic plants.
17. Field survey and documentation of local invasive species and assessment of their ecological impact.
18. Use of GPS and basic GIS tools for mapping local vegetation patterns.

References:

Textbooks

- Odum, E.P. (2004). Fundamentals of Ecology. 5th Edition. Brooks/Cole.
- Kumar, H.D. (2020). Plant Ecology: Studies in Plant Population and Ecosystem. S. Chand Publishing.
- Sharma, P.D. (2019). Ecology and Environment. Rastogi Publications.
- Bhatnagar, G., & Moitra, A. (2007). Plant Ecology. New Age International Publishers.
- Smith, R.L. (2015). Elements of Ecology. 9th Edition. Pearson.
- Mishra, R.M. (2021). Plant Ecology. Science Publishers.

Reference Books & Manuals

- Van Dobben, W.H., & De Vries, W. (Eds.)(2018). Ecological Methods for Field andLaboratory. Wiley.
- Krebs, C.J. (2016). Ecology: The Experimental Analysis of Distribution and Abundance. 7thEdition. Pearson.
- Begon, M., Townsend, C.R., & Harper, J.L. (2006). Ecology: From Individuals to Ecosystems.Blackwell Publishing.

Research Journals & Articles

- Journal of Plant Ecology (Oxford Academic)
- Plant Ecology (Springer)
- Applied Vegetation Science (Wiley)
- Recent articles on local ecological challenges published in Current Science and regionalenvironmental journals (available via university databases)

Digital Contents

- MIT OpenCourseWare: Plant Ecology modules (video lectures and lecture notes).
- NPTEL Courses on Ecology and Environment (IIT Bombay, IISc Bangalore).
- Encyclopedia of Life (EOL) for regional biodiversity data.
- GIS and Remote Sensing tutorials relevant to plant ecology (available on Coursera, ESRI site).

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Paper – VIII (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 602

Plant Growth and Development

Credits: 02 **Hours: 30 Hours**

Unit I: **Basic Concepts and Scope of Plant Growth and Development**
Introduction: Definition and distinction between growth and development.
Types and patterns of growth: Cell division, Cell elongation, Cell differentiation.
Meristems and their roles: Apical, Intercalary, Lateral meristems.
Phases of growth: Primary and Secondary growth.
Concepts of development: Morphogenesis, Differentiation, Dedifferentiation, Redifferentiation.
Impact of local environmental conditions: Effect of temperature, soil nutrients, water availability on plant growth patterns in wild orcultivated species.

Unit II: **Plant Growth Regulators and Their Applications**
Plant hormones: Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid – biosynthesis, and mechanisms of action.
Photoperiodism, vernalization and bolting in flowering plants.
Seed dormancy and germination: hormonal control and environmental influences.

Unit III: **Developmental Processes and Morphogenesis**
Organogenesis: Seed germination, seedling development, formation of root, stem, leaf, flower.
Senescence and abscission: Physiological and Biochemical aspects.
Response to environmental stimuli affecting development: Photomorphogenesis, Gravitropism, Thigmotropism.

Unit IV: **Recent Advances and Experimental Approaches**
Molecular and genetic approaches to plant growth and development. Role of signal transduction pathways in growth regulation.
Biotechnological tools for studying and manipulating plant development (e.g., CRISPR, geneediting).
Growth kinetics models and computational biology in growth studies.

Suggested Laboratory Exercises: (Any 10 Exercise representing all the four units)

1. Study and measurement of different types of growth (primary and secondary) in local plant species.
2. Microscopic study of apical, intercalary, and lateral meristems.
3. Experimental study of seed germination under varying local environmental factors (temperature, light, water).
4. Study of different dormancy breaking methods on seed germination percentage of native wild species.

5. Effects of plant growth regulators (auxin, gibberellin, cytokinin) on seedling growth and development.
6. Demonstration of Photoperiodism effects on flowering in local plants or crops.
7. Demonstration of Vernalization effects on flowering in local plants or crops.
8. Demonstration of Bolting in local rosette habit plant species.
9. Observation and analysis of plant tropic responses (Phototropism, Gravitropism, Hydrotropism).
10. Study of floral morphology and development in selected local flowering plants.
11. Measurement of growth rate parameters (absolute growth rate, relative growth rate) on local species.
12. Field survey on growth patterns of important regional crop or wild plant species under environmental stress conditions.
13. Use of simple molecular techniques (e.g., PCR for gene expression related to growth) if facilities are available.

References:

Textbooks

- Taiz, L., Zeiger, E., Møller, I.M., & Murphy, A. (2015). Plant Physiology and Development. 6thEdition. Sinauer Associates.
- Hopkins, W.G., & Huner, N.P.A. (2023). Introduction to Plant Physiology. 5th Edition. Wiley.
- Raven, P.H., Evert, R.F., & Eichhorn, S.E. (2005). Biology of Plants. 7th Edition. W.H.Freeman.
- Singh, V. (2015). Plant Growth and Development. New Age International Publishers.
- Ganapathi, T.R. (2021). Plant Growth and Development. Oxford & IBH Publishing.
- Srivastava, L.M. (2017). Plant Growth and Development - Hormones and Environment.Academic Press

Reference Books & Manuals

- Sinha, R.K. & Sanwal, S.P. (2010). Plant Growth Regulators: Principles and Applications.New India Publishing.
- Bhojwani, S.S., & Razdan, M.K. (1996). Plant Tissue Culture: Theory and Practice. Elsevier.
- Kumar, H.D. (2018). Plant Development and Reproduction. S. Chand Publishing.

Research Journals & Articles

- Plant Physiology (American Society of Plant Biologists) – for research on plant growth mechanisms and hormonal regulation.
- Journal of Experimental Botany (Oxford University Press) – contains studies on molecular biology of plant development.
- Plant Growth Regulation (Springer) – focused on plant hormones and growth responses
- Articles on locally relevant plant species growth and development in journals such as Current Science, Indian Journal of Plant Physiology, and regional agricultural research journals.

Digital Contents

- MIT Open CourseWare: Plant Growth and Development Lecture Notes and Video Lectures.
- NPTEL Courses on Plant Physiology and Development, IIT Bombay and IISc Bangalore.
- SpringerLink and ScienceDirect databases for e-books and recent articles.
- Plant Hormone Signaling Pathways tutorials available on Coursera and similar platforms.
- Local university digital repositories for theses and dissertations on plant growth studies.

Gondwana University, Gadchiroli

Theory Question Paper Pattern

B. Sc. SEMESTER – VI BOTANY (Major Papers VII and VIII)

Time: 03 Hours **Total Marks: 40**

Note: 1) All questions are compulsory and carry equal marks.
2) Draw well labelled diagram wherever necessary, but NOT necessary for Q. No. 5

Question 1. Write in detail **4 M x 2 = 08 M**

a) Unit – I
b) Unit – I

OR

c) Unit – II
d) Unit – II

Question 2. Write in detail **4 M x 2 = 08 M**

a) Unit – III
b) Unit – III

OR

c) Unit – IV
d) Unit – IV

Question 3. Write in short **2 M x 4 = 08M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit –I

OR

e) Unit –II
f) Unit – II
g) Unit – II
h) Unit – II

Question 4. Write in short **2 M x 4 = 08 M**

a) Unit – III
b) Unit – III
c) Unit – III
d) Unit –III

OR

e) Unit –IV
f) Unit – IV
g) Unit – IV
h) Unit – IV

Question 5. Write answers to any Eight questions in one or two lines only. **1 M x 8 = 08 M**

a) Unit – I	d) Unit – II	g) Unit – III	j) Unit – IV
b) Unit – I	e) Unit – II	h) Unit – III	k) Unit – IV
c) Unit – I	f) Unit – II	i) Unit – III	l) Unit – IV

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SEMESTER –VI (Level – 05.5)
Practical Examination – Botany (Major - VII)
Plant Ecology
(Based on Theory Major Paper - VII)
Course Code – USCBOT 603

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] based on Soil analysis 05 M

Que. 2: Any one Exercise [B] based on Water analysis 05 M

Que. 3: Any one Exercise [C] based on Ecological Adaptation 05 M

Que. 4: Any one Exercise [D] based on Vegetation Analysis 05 M

Que. 5: SPOTTINGS 06 M

SPOT – E : Types of Ecosystem (Specimen/Model/Photograph)
SPOT – F : Inter-specific interactions (Specimen/Model/Photograph)
SPOT – G : Nutrient Cycles (Specimen/Model/Photograph)
SPOT – H: Food Web (Specimen/Model/Photograph)
SPOT – I : Ecological Pyramids (Specimen/Model/Photograph)
SPOT – J: GPS and basic GIS tools (Specimen/Model/Photograph)

Q 6: Submission of duly certified Practical Record 02 M

Q 7: Viva-Voce. 02 M

SEMESTER –VI (Level – 05.5)
Practical Examination – Botany (Major - VIII)
Plant Growth and Development
(Based on Theory Major Paper - VI)
Course Code – USCBOT 604

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] based on Primary/Secondary growth identification 05 M

Que. 2: Any one Exercise [B] based on Meristem identification 05 M

Que. 3: Any one Exercise [C] based on Plant Movements 05 M

Que. 4: Any one Exercise [D] based on Photoperiodism/Vernalization/Flower Development 05 M

Que. 5: SPOTTINGS 06 M

SPOT – E : Primary Growth in root/stem in Monocot (Specimen/Slide/Photograph)
SPOT – F : Primary Growth in root/stem Dicot (Specimen/Slide/Photograph)
SPOT – G : Secondary Growth in root/stem Monocot (Specimen/Slide/Photograph)
SPOT – H: Secondary Growth in root/stem Dicot (Specimen/Slide/Photograph)
SPOT – I : Anomalous Primary Growth (Specimen/Slide/Photograph)
SPOT – J: Anomalous Secondary Growth (Specimen/Slide/Photograph)

Q 6: Submission of duly certified Practical Record 02 M

Q 7: Viva-Voce. 02 M

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Elective (DSE-II) Paper – II (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 605

Molecular Biology and Plant Biotechnology - II

Credits: 02 **Hours: 30**

UNIT I: Introduction to Plant Biotechnology and Plant Tissue Culture (07 Hours)

Basic Principles: Definition, history, scope, and importance of Plant Biotechnology, Concepts of totipotency and cell differentiation in plants.

Types of plant tissue culture:callus culture, organ culture, seed culture, protoplast culture

Media composition and culture conditions (MS medium basics): Components and their role.

Recent Advancements: Innovations in micropropagation techniques for elite plant varieties, Synthetic seed production and applications, Automated tissue culture and Bioreactors for large-scale propagation.

UNIT II: Haploid Production and Somatic Hybridization (08 Hours)

Haploid production: Androgenesis (Anther and Pollen culture), Gynogenesis (Ovary and Ovule culture).

Chromosome doubling: colchicine treatment and its significance Protoplast isolation, culture, and regeneration.

Somatic hybridization and Cybrid production.

Recent Advancements: Genetic and epigenetic regulation in haploid induction, Novel techniques for somatic hybridization to overcome sexual incompatibility, Use of genome editing in haploid and somatic hybrid production.

UNIT III: Genetic Engineering and Molecular Techniques in Plant Biotechnology (07 Hours)

Plant genetic transformation methods: Agrobacterium-mediated and biolistic methods, Selection markers and reporter genes, Basics of recombinant DNA technology relevant to plants, Cloning vectors and gene transfer.

Recent Advancements: CRISPR-Cas and other genome editing technologies in plants, RNA interference (RNAi)and gene silencing for crop improvement, Development of genetically modified (GM) plants for stress tolerance and improvedyield.

UNIT IV: Plant Growth-Promoting Microorganisms and Secondary Metabolite Production (08 Hours)

Basic Principles: Role of plant growth-promoting Rhizobacteria (PGPR) and fungi, Nitrogen fixation and symbiotic relationships (*Rhizobium*, Mycorrhiza), Biopesticides and biological control agents.

Biotechnology of secondary metabolite production: Cell suspension cultures and elicitors

Recent Advancements: Use of microbial inoculants for sustainable agriculture, Metabolic engineering for enhanced production of medicinal phytochemicals, Commercial applications of plant cell culture for pharmaceuticals.

Suggested Laboratory Exercises: (Any 10 Exercise representing all the four units)

1. Media preparation and sterilization techniques.
2. Initiation of callus culture from local plant explants.

3. Micropropagation of selected native species to study clonal propagation.
4. Anther culture and observation of callus development from local crop buds.
5. Protoplast isolation from native plants (demonstration or practical).
6. Chromosome doubling treatments on cultured plantlets.
7. DNA extraction from local plant species.
8. PCR amplification of target genes from regional crop varieties.
9. Demonstration of gel electrophoresis and genetic transformation protocols (simulation if facilities unavailable).
10. Isolation and characterization of PGPR from local soils.
11. Establishment of plant cell suspension cultures for secondary metabolite extraction.
12. Screening local plants for bioactive compounds using tissue culture techniques.

References:

Textbooks

- Plant Biotechnology and Genetics: Principles, Techniques, and Applications by C. Neal Stewart Jr., 3rd Edition (Wiley). Widely used as an introductory and advanced text, this book explains core plant biotechnology concepts, plant genetic engineering, transgenic crops, genome editing, and regulatory considerations.
- Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Nigel W. Scott, and Mark R. Fowler (Oxford University Press).A comprehensive examination of the technology behind genetic manipulation of plants, with clear case studies and coverage of genomic tools.
- Applied Plant Biotechnology by V. Kumaresan. Focuses on the principles and practical applications for crop improvement and bioproduction.
- Plant Biotechnology: Methods in Tissue Culture and Gene Transfer by P. K. Gupta. Targeted for postgraduate and advanced undergraduate students; includes protocols for tissue culture and genetic transformation.
- A Text Book of Plant Biotechnology by Dr. Rajeev Kumar (Rama Publishing House). Covers principles and recent developments, aligned with current university syllabi.
- Introduction to Plant Biotechnology by H.S. Chawla, latest revised edition. An accessible standard introductory textbook explaining tissue culture, molecular markers, and genetic engineering.
- Principles of Plant Biotechnology by Phundan Singh. Covers tissue culture, genetic engineering, crops improvement, and glossary for terminology.
- ***Biotechnology Expanding Horizons***.by B. D. Singh (2009), Kalyani Publications, India.

Reference Books & Manuals

- Plant Cell, Tissue and Organ Culture: Fundamental Methods by O.L. Gamburg & G.C. Phillips (Springer Lab Manuals). Detailed guidance for laboratory protocols and management in plant cell and tissue culture.
- Practical Book of Biotechnology and Plant Tissue Culture by Nagar Santosh & Adhav Madhavi. Includes step-by-step protocols and exercises for practical understanding.
- A Text Book on Principles of Plant Biotechnology by Dr. N.P. Pathak (Akinik Publications, 2024). Focuses on biotechnology's role in agriculture and the innovation of crop varieties.

Research Papers & Review Articles

- Plant Biotechnology Journal (Wiley): Publishes peer-reviewed research and reviews on transgenic plants, genome editing, and new molecular techniques.
- Plant Cell Reports (Springer): Covers innovative plant biotechnology research and technical advances.
- Annual Review of Plant Biology: Features in-depth review articles on current research trends, methods, and breakthroughs in plant biotechnology.

Articles & Digital Content

- MIT OpenCourseWare, NPTEL, and related university MOOC resources offer open-access video lectures and reading materials on plant biotechnology, genetic engineering, and crop improvement.
- Principles of Plant Biotechnology (Pravara Institute PDF): Concise online modules summarizing core tissue culture, crop improvement, and molecular tools.
- Digital library resources such as PubMed Central, ScienceDirect, and SpringerLink provide access to current research articles and e-books in Plant Biotechnology.

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Elective (DSE-II) Paper – II (2 Credits; 30 hours) (UA-40+CA-10) Course Code – USCBOT 605

Ethnobotany, Ethnomedicine and Phytochemistry - II

Credits: 02 **Hours: 30**

UNIT I: Fundamentals of Phytochemistry

Basic Principles: Introduction to phytochemistry (definition, scope, and significance).

Classification of phytochemicals: Primary and secondary metabolites (alkaloids, glycosides, terpenoids, phenolics, flavonoids, tannins, saponins), Chemical nature and biosynthesis pathways of major phytochemicals, Extraction methods and phytochemical screening tests (qualitative and quantitative).

Recent Advancements: Modern chromatographic techniques (HPLC, GC-MS) in phytochemical analysis, Metabolomics and high-throughput screening approaches, Bioinformatics tools for phytochemical data analysis.

UNIT II: Phytochemical Classes and Their Biological Activities

Basic Principles: Detailed study of alkaloids, flavonoids, tannins, phenolics, glycosides, terpenoids, and volatile oils, Biological functions of phytochemicals in plants and their pharmacological importance, Role of phytochemicals as antioxidants, antimicrobials, and anti-inflammatory agents. **Recent Advancements:** Identification of novel bioactive compounds using advanced spectroscopic methods (NMR, MS), Phytochemical modulation of human health and drug development, Application of nanotechnology in delivery of phytochemicals.

UNIT III: Techniques in Phytochemical Analysis

Basic Principles: Sample collection, preparation, and preservation for phytochemical study.

Use of chromatographic methods: TLC, column chromatography, HPLC, and GC. **Spectroscopic techniques:** UV-Vis, IR, NMR, Mass Spectrometry basics.

Bioassays for phytochemical activity evaluation.

Recent Advancements: Integration of hyphenated techniques (GC-MS, LC-MS/MS) in complex mixtures analysis, Automation and miniaturization in phytochemical studies, Computational approaches for molecular docking and activity prediction.

UNIT IV: Applications and Recent Trends in Phytochemistry

Basic Principles: Role of phytochemicals in pharmacognosy and drug discovery, Herbal drug standardization and quality control.

Phytochemistry in agriculture: natural pesticides, growth regulators, Conservation of medicinal plants and sustainable utilization.

Recent Advancements: Phytochemical genomics and metabolic engineering, Nanoformulations and phytochemical delivery systems, Trends in herbal cosmetology and nutraceuticals.

Suggested Laboratory Exercises:

1. Extraction of phytochemicals from indigenous plantscommon in the region using solvents.
2. Qualitative tests for alkaloids, flavonoids, tannins, saponins, terpenoids in local plant samples.
3. Thin-layer chromatography (TLC) of phytochemical extracts from regional medicinal plants.
4. Quantitative estimation of phenolics and flavonoids in native plant extracts.

5. Antioxidant activity assay of regional plant samples (e.g., DPPH assay).
6. Preparation and analysis of herbal formulations from local plant sources.
7. Extraction and fractionation of phytochemicals from local plants.
8. TLC profile comparison of multiple local plant extracts.
9. Demonstration of quantitative HPLC or spectrophotometric analysis (if available).
10. Bioassay-based screening of local plant extracts for antimicrobial or antioxidant activity.
11. Preparation and standardization of herbal extracts and formulations from local plants.
12. Study of phytochemical effects on seed germination or pest deterrence in indigenous crops.
13. Survey and documentation of local ethnomedicinal plants and their phytochemical uses.

References:

Textbooks

- **Textbook of Pharmacognosy and Phytochemistry** (2012, Elsevier Health Sciences) — This comprehensive textbook covers alternative medicinal systems and modern pharmacognosy, biosynthetic pathways of metabolites, extraction and isolation methods, and applications of Ayurvedic and Chinese medicinal plants. It includes over 300 illustrations and is suitable for pharmacy and botanical students.
- **Textbook of Pharmacognosy and Phytochemistry** by Biren Shah and Vinash Seth — A modern interdisciplinary book emphasizing plant biodiversity, biosynthesis, extraction, isolation techniques with TLC identification, and bioactivity assessment. It includes chapters on Ayurvedic, marine medicinal plants, nutraceuticals, cosmeceuticals, and other specialized topics, oriented toward undergraduate and postgraduate students and researchers.
- **A Text Book of Pharmacognosy and Phytochemistry-I** (2024) by Sunil Dutt, Rajesh Kumar, and Pankaj Kalia (Bright Sky Publications) — This recently published book explores medicinal plants, chemical constituents, their pharmacological activities, and therapeutic applications with an interdisciplinary approach integrating botany, chemistry, and traditional medicine.
- **Pharmacognosy and Phytochemistry-II** by Himanshu Singh et al. — A continuation volume providing detailed coverage of phytochemical study and pharmacognosy aspects.
- **Pharmacognosy & Phytochemistry Series (Springer Reference Series)** — An ongoing book series covering plant metabolites, their chemistry, properties, applications, and analytical methods relevant to phytochemistry research and applications.
- *Text Book of Economic Botany, Ethnomedicine and Phytochemistry* (2023) — This textbook aligns with NEP 2020 syllabus requirements and covers phytochemistry fundamentals, economic botany, and ethnomedicinal plants in an integrated manner, suitable for B.Sc. students.
- *Textbook of Pharmacognosy and Phytochemistry-II* (Shashwat Publication, 2025) — A comprehensive text focusing on the chemical and biological aspects of medicinal plants and crude drug evaluation, covering phytochemicals extensively.
- *Pharmacognosy and Phytochemistry* (syllabus documents for various Indian universities, e.g., MLSU course BP 405) — These outline fundamentals of pharmacognosy including classification and evaluation of phytochemicals and crude drugs.
- *Plant Biochemistry and Metabolism* sections from university syllabi like Himachal Pradesh University cover biosynthesis and function of secondary metabolites such as phenolics, flavonoids, terpenoids, alkaloids, and steroids.

Reference Books

- *Economic Botany, Ethnomedicine and Phytochemistry* across Indian universities provides substantial information on commercial and medicinal plants, oils, dyes, and phytochemical constituents with practical relevance.
- Standard plant biochemistry texts cited in syllabi (e.g., Lehninger's *Biochemistry*, Berg et al.'s *Biochemistry*) provide foundational biochemical background related to phytochemistry, metabolism, and secondary metabolites.
- Compendiums on medicinal plants and phytochemical analysis methods used in Pharmacy and Botany curricula.

Research Papers and Journals

- For recent phytochemical research, review journals like *Journal of Ethnopharmacology*, *Phytochemistry*, *Phytochemical Analysis*, and open-access repositories (Google Scholar, PubMed) provide peer-reviewed research on plant secondary metabolites, their extraction, characterization, and medicinal applications.

Digital Contents and Open-access Resources

- Coursenotes, PDFs, and open educational materials from Indian universities such as Vardhman Mahaveer Open University, Uttarakhand Open University, and TNAU Agritech Portal that cover phytochemistry basics, secondary metabolites, tests for phytochemicals, and their applications.

Additional Educational Resources

- Syllabus-aligned textbooks combining *Economic Botany, Ethnomedicine and Phytochemistry* by authors like Dr. Devesh Kumar Jadon are used in many Indian B.Sc. programs under the National Education Policy (NEP 2020).

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Elective (DSE-II) Paper – II (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 605

Mycology and Plant Pathology - II

Unit-I

1. Introduction, definition objectives importance of plant disease and plant pathology in 20th century.
2. Classification of plant disease on the basis of casual agents (non-parasitic & parasitic) and symptoms caused by fungi.
3. Method of studying plant disease – field observations, cutting of pathogenic organisms, culture media preparation, sterilization, isolation & purification & identification of culture, Koch's postulates.

Unit-II

1. Impact of Environment on plant disease – effect of temperature, soil environment, relative humidity soil types & texture, wind, rainfall & light.
2. Enzymes & toxins in plant diseases – cellulolytic enzyme, pecticemzymes, pytotoxins, vivotoxins & pathotoxins.
3. Defense mechanisms in plants – defense structures (Waxes & cuticles, structure of epidermal cell wall, structure of natural openings, cork layers, tyloses, gum deposition, synthesis of phenols) & hypersensitive reaction.
4. Principles of plant disease control – biological & chemical control, uses of disease resistance varieties & plant quarantine

Unit-III

Study of following disease with respect to symptoms, casual organisms, disease cycle & management.

1. Cereals:
   a) Grain Smut of Jowar b) Ergot of Bajra
2. Pulses:
   a) Wilt of pigeon Pea b) Yellow vein mosaic of Bean
3. Vegetables:
   a) Late blight of Potato b) Little leaf of Brinjal
4. Oil seeds:
   a) Tikka disease of Groundnut. b)Damping of Mustard.

Unit-IV

Study of following disease with respect to symptoms, casual organisms, disease cycle & management.

1. Fruits – Citrus Canker
2. Cash Crops
   a) Wilt Disease of Cotton b) Red Rot of Sugarcane
3. Ornamentals – Powdery Mildew of Rose
4. Weeds – Rust of *Euphorbia*
5. Trees – *Cercospora* on *Albizzia* fruits.

Laboratory Exercises: -

Make use of permanent micro-preparation, temporary mounts, transparencies, photographs, charts etc.

1. Principles & working of tools, Equipment's and other requirements in the Mycology & Plant Pathology laboratory.
2. Collection of disease plant parts from surrounding locality.
3. Identification of diseased material, their symptoms and characters (Disease plants studied in syllabus).
4. Sterilization Processes viz. Moist heat, Dry heat, Chemical and Radiation.
5. To study the Preparation of Potato Dextrose Agar (PDA).
6. Pouring of Nutrient Media into Petri dishes and Slant preparation.
7. Isolation of fungal pathogen from leaves.
8. Isolation of fungal pathogen from stems fruits and other aerial part.
9. Preparation of pure culture of Fungi and its identification.
10. Artificial inoculation of pathogen from diseased plant part to Petri dishes containing nutrient media.
11. Pathogenicity Test – Steps to perform Koch's Postulates.
12. To test the sensitivity of microorganism against antibiotics.

Suggested Readings:

1. A text book of Modern Plant Pathology – K. S. Bilgrami & H. C. Dube
2. Experiments in Microbiology, Plant Pathology and Biotechnology – K. R. Aneja
3. Plant Pathology – R. S. Mehrotra
4. Plant Pathology – C. J. Walker
5. Fundamental of Plant Pathology – N. G. Ravichandra
6. Disease of Crop Plants in India – G. Rangaswami & A. Mahadevan

NOTE:

Frequent field visits in the surrounding areas to study the disease plant vegetation (Hosts) are necessary.

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Elective (DSE-II) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 605

Paleobotany - II

UNIT – I:

1. GEOLOGICAL TIME SCALE

Origin and evolution of the Earth; Origin and organic evolution of life on Earth; Henry Miller Experiment; Geological Time Scale

UNIT – II:

2. THEORIES OF ORIGIN AND EVOLUTION OF THE EARTH

Nebular Hypothesis; Laplace's Hypothesis; Planet Assimal Hypothesis; Tidal Theory; Binary Star Hypothesis; Supernova Hypothesis; Interstellar Hypothesis; Big Bang Theory

UNIT – III:

3. ROCK SYSTEM OF INDIA

Archean Rock; Purana Rock; Dravidian Rock; Aryan Rock

4. Earth Movement

Different Layers of Earth; Continental Drift Theory; Plate Tectonic Theory

UNIT – IV:

5. APPLIED PALAEOBOTANY

Fossil Fuels- Coal and Collification; Classification of Coal; Coal Excavation and Paleopalynology; Origin of Oil; Oil Exploration and Paleopalynology; Paleo-Ecology and Paleofloristics

Laboratory Exercises:

1. Study of Geological Time Scale Table from chart.
2. Study of Henry Miller Experiment from chart.
3. Study of different theories of origin and evolution of the earth.
4. Study of different rock system of India.
5. Study of different layers of earth by diagram.
6. Study of different theories of earth movement.
7. Study of Classification of Coal.
8. Study the process of Oil exploration from earth.

Suggested Readings:

1. Stewart, W.N. and Rothwell G.W. (1993): Palaeobotany and the Evolution ofPlants, Cambridge University Press.

2. Foster A.S. & Gifford F.M. (1967): Comparative morphology of vascular plants,Freeman Publishers, San Fransisco.

3. Eames, A.J. (1974): Morphology of Vascular Plants- lower groups, Tata Mc-Graw Hill publishing Co., New Delhi.

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5. Kubitzki K. (1990): The families and genera of vascular plants Pteridophytes and

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B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Elective (DSE-II) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 605

Biodiversity Conservation - II

Unit I: Conservation of Different Ecosystems and Biomes

1. Forest Ecosystems
    i) Types (Tropical & Temperate) and characteristics of forest ecosystems
    ii) Importance of forest biodiversity
    iii) Conservation issues: deforestation, habitat loss and fragmentation
    iv) Forest conservation and management strategies
2. Wetland and Freshwater Ecosystems
    i) Types and ecological importance of wetlands and freshwater ecosystems
    ii) Biodiversity values and ecosystem services
    iii) Threats: pollution, habitat degradation and invasive species
    iv) Conservation strategies and restoration of wetlands
3. Marine and Coastal Ecosystems
    i) Types: mangroves, coral reefs, estuaries and seagrass ecosystems
    ii) Importance of marine and coastal biodiversity
    iii) Threats: pollution, overexploitation and climate change
    iv) Protection and management strategies
4. Grassland and Desert Ecosystems
    i) Characteristics and biodiversity of grasslands and deserts
    ii) Ecological importance and adaptations of desert plants
    iii) Conservation challenges: habitat loss, overgrazing and desertification
    iv) Management and restoration approaches
5. Agroecosystems and Biodiversity Conservation
    i) Concept and components of agroecosystems
    ii) Importance of agricultural biodiversity
    iii) Threats to agro-biodiversity
    iv) Sustainable agriculture and conservation practices

Unit II: Conservation Policy, Legislation, and Governance

1. Biodiversity Conservation Policies and Action Plans
    i) National biodiversity policy frameworks
    ii) National Biodiversity Action Plan (NBAP)
    iii) Objectives and significance of biodiversity governance
2. Wildlife Laws and Legal Frameworks
    i) Wildlife Protection Act, 1972 (amendments and key provisions)
    ii) Forest Conservation Act, 1980
    iii) Role of legislation in biodiversity conservation
3. Organizations Involved in Biodiversity Conservation
    i) Role of governmental organizations:
        - Ministry of Environment, Forest and Climate Change (MoEFCC)
        - National Biodiversity Authority (NBA)
        - Forest Department
    ii) Role of non-governmental organizations in conservation

4. Community-Based Conservation and Traditional Knowledge
    i) Concept and importance of community participation
    ii) Indigenous knowledge systems in biodiversity conservation
    iii) Sacred groves and local conservation practices
5. Environmental Impact Assessment and Biodiversity Management
    i) Concept and objectives of Environmental Impact Assessment (EIA)
    ii) Biodiversity impact assessment
    iii) Biodiversity Management Plans (BMPs)

Unit III: Socioeconomic and Cultural Aspects of Biodiversity Conservation

1. Biodiversity and Human Well-being
    i) Relationship between biodiversity and human societies
    ii) Ecosystem services and their importance for livelihoods
    iii) Dependence of communities on biological resources
2. Ecotourism and Sustainable Livelihoods
    i) Concept and principles of ecotourism
    ii) Role of ecotourism in biodiversity conservation
    iii) Sustainable use of biodiversity resources
3. Conservation Conflicts and Challenges
    i) Human–wildlife conflict: causes and management
    ii) Resettlement and rehabilitation issues in conservation areas
    iii) Balancing conservation and development needs
4. Education and Awareness in Biodiversity Conservation
    i) Role of environmental education and awareness programmes
    ii) Public participation in biodiversity protection
    iii) Role of media and outreach activities
5. Ethical and Philosophical Aspects of Conservation
    i) Environmental ethics and conservation values
    ii) Importance of sustainable and responsible use of biodiversity
    iii) Human responsibility towards biodiversity protection

Unit IV: Contemporary Issues and Future Directions in Biodiversity Conservation

1. Climate Change and Biodiversity Conservation
    i) Impact of climate change on biodiversity and ecosystems
    ii) Adaptive management strategies for biodiversity conservation
2. Role of Technology in Biodiversity Conservation
    i) Applications of remote sensing, GIS and GPS
    ii) Use of drones, artificial intelligence (AI) and big data in biodiversity monitoring
    iii) Digital tools for biodiversity documentation and management
3. Conservation Genomics and Biotechnology
    i) Concept and applications of conservation genomics
    ii) Emerging biotechnological tools in species conservation
    iii) Genetic approaches for conservation and restoration
4. Invasive Species Management
    i) Concept and impacts of invasive alien species
    ii) Prevention, control and management strategies
    iii) Restoration of affected ecosystems

5. Future Perspectives in Biodiversity Conservation
    i) Emerging approaches and innovations in conservation
    ii) Sustainable and technology-based conservation strategies
    iii) Integrating science, policy and community participation

SUGGESTED LABORATORY EXERCISES

UNIT I: Conservation of Different Ecosystems and Biomes

1) Documentation of Forest Ecosystem Types and Assessment of Forest Biodiversity
2) Assessment of Wetland and Freshwater Ecosystem Biodiversity and Conservation Status
3) Documentation and Demonstration of Marine and Coastal Ecosystems and Their Conservation
4) Study of Grassland and Desert Ecosystems with Special Reference to Plant Adaptations
5) Documentation of Agroecosystems and Sustainable Biodiversity Conservation Practices

List of Spotting

1) Forest Ecosystem Model/Chart (Tropical and Temperate Forests)
2) Wetland Ecosystem Specimen/Chart (Ramsar Wetland Example)
3) Mangrove Ecosystem Specimen (Prop Roots of *Rhizophora*)
4) Desert Plant Adaptation Specimen (*Opuntia*, *Aloe*, *Cactus*)
5) Agroecosystem Biodiversity Specimen (Traditional Crop Varieties/Seed Diversity)

UNIT II: Conservation Policy, Legislation, and Governance

1) Documentation of National Biodiversity Policies and Action Plans
2) Study and Demonstration of Wildlife Conservation Laws and Legal Frameworks
3) Documentation of Organizations Involved in Biodiversity Conservation
4) Survey and Documentation of Community-Based Conservation Practices and Traditional Knowledge
5) Preparation of Biodiversity Impact Assessment and Biodiversity Management Plan

List of Spotting

1) Wildlife Protection Act, 1972 – Conservation Schedule/Legal Document
2) Forest Conservation Act, 1980 – Objectives and Provisions Chart
3) National Biodiversity Authority (NBA) – Structure and Functions Chart
4) Sacred Grove Photograph/Chart (Community Conservation Practice)
5) Environmental Impact Assessment (EIA) Process Flow Chart

UNIT III: Socioeconomic and Cultural Aspects of Biodiversity Conservation

1) Documentation of Biodiversity-Based Ecosystem Services and Human Dependence on Biological Resources
2) Study of Ecotourism Models and Sustainable Livelihood Practices
3) Assessment and Documentation of Human–Wildlife Conflict and Conservation Challenges
4) Preparation of Biodiversity Awareness and Education Programme Materials
5) Documentation of Environmental Ethics and Sustainable Biodiversity Utilization Practices

List of Spotting

1) Ecosystem Services Chart (Provisioning, Regulating, Cultural and Supporting Services)
2) Ecotourism Model/Chart (Sustainable Tourism Practices)
3) Human–Wildlife Conflict Case Study Chart
4) People's Participation in Conservation (Community-Based Conservation Model)
5) Sacred Plants and Cultural Conservation Examples (*Tulsi*, *Neem*, *Peepal*)

UNIT IV: Contemporary Issues and Future Directions in Biodiversity Conservation

1) Assessment of Climate Change Impacts on Biodiversity and Ecosystem Adaptation Strategies
2) Demonstration of Remote Sensing, GIS, GPS and Digital Tools in Biodiversity Monitoring
3) Demonstration of Conservation Genomics and Biotechnological Tools in Species Conservation
4) Documentation and Management Strategies of Invasive Alien Species
5) Preparation of Future Conservation Strategies Using Science, Technology and Community Participation

List of Spotting

1) Climate Change Impact on Biodiversity Chart (Global Warming Effects)
2) Remote Sensing and GIS Application in Biodiversity Mapping (Satellite Image/Map)
3) DNA Barcoding / Conservation Genomics Demonstration Chart
4) Invasive Alien Species Specimen (*Lantana camara*, *Parthenium hysterophorus*, *Eichhornia crassipes*)
5) Biotechnology Tools in Conservation (Tissue Culture, Cryopreservation, DNA Bank Models)

Suggested Readings

1) Chiras, D. D., & Reganold, J. P. (2010). *Natural resource conservation: Management for a sustainable future* (10th ed.). Boston, MA: Pearson Education.
2) Gadgil, M., & Guha, R. (1995). *Ecology and equity: The use and abuse of nature in contemporary India*. London, UK: Routledge.
3) Gaston, K. J., & Spicer, J. I. (2004). *Biodiversity: An introduction* (2nd ed.). Oxford, UK: Blackwell Publishing.
4) Groom, M. J., Meffe, G. K., & Carroll, C. R. (2006). *Principles of conservation biology* (3rd ed.). Sunderland, MA: Sinauer Associates.
5) Hunter, M. L., Gibbs, J. P., & Sterling, E. J. (2021). *Problem-solving in conservation biology and wildlife management* (2nd ed.). Chichester, UK: Wiley-Blackwell.
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7) Primack, R. B. (2014). *Essentials of conservation biology* (6th ed.). Sunderland, MA: Sinauer Associates.
8) Primack, R. B., & Corlett, R. T. (2019). *Tropical rainforest conservation: Ecology, management, and restoration*. Oxford, UK: Oxford University Press.
9) Ramakrishnan, P. S., Saxena, K. G., & Chandrashekara, U. M. (Eds.). (1996). *Conserving the sacred for biodiversity management*. New Delhi, India: Oxford & IBH Publishing.
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11) Sharma, P. D. (2021). *Ecology and environment* (14th ed.). Meerut, India: Rastogi Publications.
12) Singh, J. S., Singh, S. P., & Gupta, S. R. (2017). *Ecology, environmental science and conservation* (4th ed.). New Delhi, India: S. Chand Publishing.
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B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Major Elective (DSE-I) Paper – I (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCBOT 605

Reproductive Biology of Angiosperm – II

Credits: 02 **Hours: 30**

Unit I

Pollen-pistil interaction and post pollination events.

Fertilization: Path of pollen tube in pistil; double fertilization, triple fusion and its significance. In-vitro approaches to the study of fertilization-Intra-ovarian pollination, test tube fertilization, in vitro pollination, placental pollination, Cybrids, in vitro fertilization.

Post fertilization changes and Endosperm developement, Types of endosperms. embryo-endosperm relationship, role of endosperm in embryo development.

Polyembryony: Defination, causes, classification, induction of polyembryony, practical importance of polyembryony.

Unit II

Embryogenesis: Zygote and its ultra-structure, Types of embryogeny, Embryogenesis in dicots and Monocots, Structure of dicot & Monocot Embryo.

Suspensor- Ultra structure of suspensor cells and its role. Nutrition of embryo- nutrient supply of the zygote.

Development of seed and seed type: Changes occurring during seed development, Factors affecting seed development, Seed viability or Longevity of Seeds, Factors affecting seed Germination, Types of Seed , Structure of a Dicotyledonous and monocotyledonous Seed.

Apomixis: Definition, causes, classification, - Diplospory, Apospory, pseudogamy, autogamous development of endosperm, causes of apomixIs, significance.

Unit III

Seed Dormancy: Types of Seed Dormancy (Exogenous Dormancy, Endogenous Dormancy) Factors Responsible for Seed Dormancy (Environmental Factors and Reasons for Seed Dormancy) Importance of Seed Dormancy, Methods to Overcome Dormancy, Bud Dormancy.

Seed appendages and special Structures, Adaptations, and Functions (Sarcotestal Seeds, Arillate Seeds, Jaculator, Winged Seeds, Haired Seeds, Dust and Balloon Seeds, Hydrochoric Seeds, Mucilage Seeds).

Unit IV

Development of Fruit and Fruit type: Fruit Types (On basis of origin, composition, fruit ripening) Dehiscence of Fruits, Dynamics of Fruit Growth, Fruit set, Fruit Maturation, Fruit Ripening/senescence.

Fruit and Seed Dispersal: Mechanism and types of dispersal, Active Dispersal of Seeds (Autochoric Seeds), Significance of fruit and seed dispersal.

Seed germination, types of seed germination (1) Hypogeal Germination (2) Epigeal Germination and (3) Vivipary (Viviparous Germination).

Suggested Laboratory exercise (Any 10)

1.To study dicot (non-endospermic) and monocot (endospermic) seeds
2.To study dicot and monocot embryo development through various stages in given seeds (slides/photographs/fresh material).
3. To demonstrate seed viability test by T.T.C. (Triphenyl-Tetrazolium-chloride).
4. To study factors affecting seed germination.
5. To study Intra-ovarian pollination (slides/photographs/fresh material).
6. To study test tube fertilization. (slides/photographs/fresh material).
7. To study in vitro pollination. (slides/photographs/fresh material).
8. To study different types of Endosperms.

9. To study seed germination types Hypogeal Germination and Epigeal Germination.
10. Dissection of young seeds for endosperm with free-nuclear haustoria.
11. To study polyembryony. (slides/photographs/fresh material).
12. To study different appendages and special structure in seed (slides/photographs/fresh material).
13. To study the Vivipary. (Floral buds and Seeds) (slides/photographs/fresh material).
14 . To study Seed and Fruit dispersal mechanisms (slides/photographs/fresh material).
15).To study different types of fruits (slides/photographs/fresh material).
16).To study the various methods of breaking seed dormancy.
17). To study dehiscence of fruits (slides/photographs/fresh material).

Suggested Readings

Asker S. 1979, Progress in apomixis research. Hereditas 91, 231-240.
Barnier, G. 1986, The flowering process as an example of plastic development. Soc. Expt.. Biol. 40: 257-286.
Barth, F.G. 1991, insects and flowers, Princeton Univ. Press. Princeton.
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Bewley, J.D. and Black, M. (1994). Seeds Physiology of Development and Germination. Plenum Press, New York. 15.
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Bhojwani S.S/Bhatnagar S.P. & Dantu P.K. 2015. The Embryology of Angiosperms, 6th Edition Front Cover Vikas Publishing House.
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Jacobsen, J.V. (1984). The Seed: Germination. In: Johri, B.M. (eds) Embryology of Angiosperms. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-69302-1_13
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Lakshmanan, K.K., Ambegaokar, K.B. (1984). Polyembryony. In: Johri, B.M. (eds) Embryology of Angiosperms. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-69302-1_9
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Mauro Cresti, Stephen Blackmore, Jacobus L. van Went (2012). Atlas of Sexual Reproduction in Flowering Plants. Springer Verlag Berlin.
Mishra SR (2009) Understanding Plant Reproduction. Discovery Publishing House New Delhi.
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Raghavan, V. (1997). Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
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Swamy, B. G. L. and D. Padmanabhan. 1962. A reconnaissance of angiosperms embryogenesis. Jour. Indian Bot. Soc. 41: 422-

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Vijayaraghavan, M.R., Prabhakar, K. (1984). The Endosperm. In: Johri, B.M. (eds) Embryology of Angiosperms. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-69302-1_7

Gondwana University, Gadchiroli

Theory Question Paper Pattern

B. Sc. SEMESTER – VI BOTANY (Major Papers DSE - II)

Time: 03 Hours **Total Marks: 40**

Note: 1) All questions are compulsory and carry equal marks.
2) Draw well labelled diagram wherever necessary, but NOT necessary for Q. No. 5

Question 1. Write in detail **4 M x 2 = 08 M**

a) Unit – I
b) Unit – I

OR

c) Unit – II
d) Unit – II

Question 2. Write in detail **4 M x 2 = 08 M**

a) Unit – III
b) Unit – III

OR

c) Unit – IV
d) Unit – IV

Question 3. Write in short **2 M x 4 = 08M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit –I

OR

e) Unit –II
f) Unit – II
g) Unit – II
h) Unit – II

Question 4. Write in short **2 M x 4 = 08 M**

a) Unit – III
b) Unit – III
c) Unit – III
d) Unit –III

OR

e) Unit –IV
f) Unit – IV
g) Unit – IV
h) Unit – IV

Question 5. Write answers to any Eight questions in one or two lines only. **1 M x 8 = 08 M**

a) Unit – I	d) Unit – II	g) Unit – III	j) Unit – IV
b) Unit – I	e) Unit – II	h) Unit – III	k) Unit – IV
c) Unit – I	f) Unit – II	i) Unit – III	l) Unit – IV

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SEMESTER –VI (Level – 05.5)
Practical Examination – Botany (Major DSE - II)

(Based on Theory Major DSE-II)
Course Code – USCBOT 606

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] based on exercise from Unit I	05 M
Que. 2: Any one Exercise [B] based on exercise from Unit II	05 M
Que. 3: Any one Exercise [C] based on exercise from Unit III	05 M
Que. 4: Any one Exercise [D] based on exercise from Unit IV	05 M
Que. 5: SPOTTINGS SPOT – E :From Unit I SPOT – F :From Unit II SPOT – G :From Unit III SPOT – H: From Unit IV	04 M
Q 6: Submission of duly certified Practical Record	02 M
Q. 7 Submission of Institution Visit Report	02 M
Q 8: Viva-Voce.	02 M

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Minor Paper – IV (2 Credits; 30 hours) (UA-40+CA-10)
Course Code – USCMEMB 07

Medicinal Botany

Credits: 04 **Hours: 60**

Unit I: **Introduction, History, Scope, and Significance**

Introduction: Definition, Scope, Historical perspective and contribution of India to Medicinal Botany.

Indigenous medicinal systems: Ayurveda, Siddha, Unani, and Homeopathy. Importance of medicinal plants in human health and traditional knowledge

Plant parts used as medicines: roots, stems, leaves, flowers, fruits, seeds and fruits as medicine. Important medicinal plants in the local region and theirtraditional uses.

Conservation status and threats to medicinal plants: Red List, Endemism, and sustainableharvesting.

Unit II: **Phytochemistry, Pharmacognosy, and Plant Drug Sources**

Overview of phytochemicals: Alkaloids, Flavonoids, Tannins, Glycosides, Terpenoids, Saponins, Phenolics. Extraction and isolation techniques for plant bioactive compounds.

Pharmacognosy: Identification, authentication, and quality control of medicinal plants, Adulteration and contamination of crude drugs; powder drug analysis techniques.

Local exploration: Phytochemical profiling of locally available medicinal plants, Ethnobotanical approaches and documentation of medicinal plant knowledge in the region.

Unit III: **Cultivation, Processing, and Applications of Medicinal Plants**

Agro-techniques and inter-culture practices: Cultivation practices, nursery techniques, harvesting, and post-harvest processing of selected important medicinal plants (e.g.,*Withania* sp., *Aloe* sp., *Rauwolfia* sp.).

Industrial applications: Herbal drug formulations, standardization, and dosage. Role of medicinal plants in pharmacy, cosmetics, and nutraceutical industries.

Local relevance: Cultivation challenges and economic value of medicinal plants in the localagricultural context.

Legal and ethical considerations: Intellectual Property Rights (IPR) and regulationsin herbal drug production.

Unit IV: **Recent Advances, Biotechnology, and Conservation**

Advances in tissue culture techniques and micropropagation of medicinal plants (***Artemisia annua, Bacopa moneri***).

Molecular tools for authentication and genetic improvement of medicinal plants. Bioinformatics databases and their role in medicinal plant research.

Conservation strategies:*In situ* and *ex situ* methods, bioprospecting, and sustainable use. Local conservation programs and community-based medicinal plant management.

Emerging research on medicinal plants targeting local health issues and drug discovery.

Suggested Laboratory and Field Exercises

1. Identification and morphological study of local important medicinal plants.

2. Preparation and preservation of herbarium sheets of medicinal plants.
3. Microscopic examination of powdered crude drugs and plant parts.
4. Phytochemical screening tests for key secondary metabolites (alkaloids, flavonoids, tannins,etc.).
5. Extraction techniques for essential oils and other bioactive compounds.
6. Germination tests and nursery practices for selected medicinal plants.
7. Study of traditional herbal formulations and their preparation.
8. Field survey and documentation of medicinal plants in local ecosystems
9. Preparation of plant drug samples for adulteration tests.
10. Visit to a local herbal farm or industry for practical exposure

REFERENCES

Textbooks

- **Medicinal Plants: Chemistry, Biology and Omics** by Seema Rawat, Pratibha Misra,Springer Nature, 2021.
- **Pharmacognosy and Phytochemistry** by Vinod D. Rangari, 2nd Edition, Career Publications.
- **Medicinal Botany** by N.S. Subrahmanyam, CBS Publishers, 2015.
- **Textbook of Pharmacognosy & Phytochemistry** by T.E. Wallis, CBS Publishers.
- **Handbook of Medicinal Plants** by K.V. Peter, 2nd Edition, CRC Press.

Reference Books & Manuals

- **Pharmacognosy and Pharmacobiotechnology** by Ashutosh Kar, New Age International.
- **Medicinal Plants: Conservation, Cultivation and Utilization** by A.K. Singh, PointerPublishers.
- **Plant Drug Analysis: A Thin Layer Chromatography Atlas** by H. Wagner & S. Bladt,Springer.
- **Medicinal Plant Biotechnology** edited by M. Ahmad et al., Wiley-Blackwell.

Research Journals & Articles

- Journal of Ethnopharmacology (Elsevier)
- Economic Botany (Springer)
- Phytochemistry Reviews (Springer)
- Recent research articles on local medicinal plants published in Current Science, IndianJournal of Traditional Knowledge, and regional botanical journals

Digital Content & Online Resources

- NPTEL online courses on Medicinal Plants and Pharmacognosy.
- MIT OpenCourseWare: Medicinal Plant Biology modules.
- Digital herbarium and ethnobotanical databases such as The Plant List, Kew Medicinal Plant Names Services
- PubMed Central and Science Direct for latest manuscripts on medicinal plant research.
- Herbal pharmacopoeia and drug regulatory information from WHO and AYUSH ministry websites.

Gondwana University, Gadchiroli

Theory Question Paper Pattern

B. Sc. SEMESTER – VI BOTANY (Minor Paper IV)

Time: 03 Hours **Total Marks: 40**

Note: 1) All questions are compulsory and carry equal marks.
2) Draw well labelled diagram wherever necessary, but NOT necessary for Q. No. 5

Question 1. Write in detail **04 M x 02 = 08 M**

a) Unit – I
b) Unit – I

OR

c) Unit – II
d) Unit – II

Question 2. Write in detail **04 M x 02 = 08 M**

a) Unit – III
b) Unit – III

OR

c) Unit – IV
d) Unit – IV

Question 3. Write in short **02 M x 04 = 08M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit –I

OR

e) Unit –II
f) Unit – II
g) Unit – II
h) Unit – II

Question 4. Write in short **02 M x 04 = 08M**

a) Unit – III
b) Unit – III
c) Unit – III
d) Unit –III

OR

e) Unit –IV
f) Unit – IV
g) Unit – IV
h) Unit – IV

Question 5. Write answers to any Eight questions in one or two lines only. **1 M x 08 = 08 M**

a) Unit – I
b) Unit – I
c) Unit – I
d) Unit – II
e) Unit – II
f) Unit – II
g) Unit – III
h) Unit – III
i) Unit – III
j) Unit – IV
k) Unit – IV
l) Unit – IV

Practical Examination

B. Sc. SEMESTER – VI (Level 05.5)

Subject – Botany (Minor)

Medicinal Botany

Course Code: USCMEMB 08

[Time 4 Hours] [Max. Marks – 30]

Que. 1: Any one Exercise [A] based on Morphology study and identification of medicinal plant 05 M

Que. 2: Any one Exercise [B] based on Powder Microscopy of medicinal plant parts. 05 M

Que. 3: Any one Exercise [C] based on qualitative identification of Phytochemicals from crude extract 05 M

Que. 4: Any one Exercise [D] based on preparation of Herbal formulation 05 M

Que. 5: SPOTTINGS 06 M

SPOT – E : Roots used as Medicine (Specimen/Photograph)
SPOT – F : Stem used as Medicine (Specimen/Photograph)
SPOT – G : Leaves used as Medicine (Specimen/Photograph)
SPOT – H: Fruits used as Medicine (Specimen/Photograph)
SPOT – I : Seeds used as Medicine (Specimen/Photograph)
SPOT – J: Locally available commercial Herbal Formulation (Specimen/Photograph)

Q 7: Submission of duly certified Practical Record 02 M

Q 8: Viva-Voce. 02 M

B. Sc. Botany (NEP2020)
SEMESTER – VI (Level 05.5)
Research Project Based on Major Subjects (4 Credits; 120 hours) (UA-60 +CA-40)
Course Code – USCRP

A detailed guideline for conduction and evaluation of the Field Project (FP)/ Research Project (RP) will be provided by the University separately.

B. Sc. Botany (NEP2020)

SEMESTER – VI (Level 05.5)

IKS SS (2 Credits; 30 hours) (UA-40 + CA-10)

Core Course: Indian Knowledge System in Botany – II

Total Hours: 30 **Credits: 2**

Unit I: Ethnobotany and Traditional Plant Knowledge : 8 Hours

Topic	Subtopics	Teaching Scope	Hours
1. Concept and Scope of Ethnobotany	- Definition, interdisciplinary nature	- Introduce Ethnobotany as a bridge between culture and Botany	3
	Importance in documenting tribal knowledge	Emphasize role of local/tribal communities	
2. Tribal and Ethnic Groups of India and Their Plant Knowledge	- Major and minor tribal groups	- Present examples from different regions (e.g., Central India – Madia, Gond, Baiga, North-East India – Khansi, Santhal, Naga)	3
	Plant use among different communities	Show variation in plant uses	
	Case studies of tribal flora	Discuss oral transmission of knowledge	
3. Documentation and Preservation of Ethnobotanical Knowledge	- Field methods, interviews, specimen collection	- Teach basic field documentation skills - Herbarium, Ancient Literature, Archaeological findings, Temples and sacred places etc.	2
	Digital ethnobotany and databases	Introduce digital tools for Ethnobotany	

Unit II: Medicinal Plants and Traditional Knowledge : 8 Hours

Topic	Subtopics	Teaching Scope	Hours
2. Traditional Plant-Based Therapies and Practices	Herbal formulations (Kwath, Churna, Ghrita)	- Explain preparation methods	3
	Seasonal usage of medicines	-Discuss seasonal therapy (Rasayana)	
3. Plants of Ethnobotanical importance	Classification of ethnobotanical plants on the basis of their uses. Food plants (Vegetables, Fruits and Seeds), Intoxicants and Beverages, Resins and Oils, Medicine and Narcotics and Miscellaneous uses	- Describe key features of plants - Discuss traditional uses and modern validations - Include local and regional examples	3
3. Local Ethnobotanical diversity	Ethnobotanical study of Chandrapur and Gadchiroli region	- Highlight major studies and research findings carried out in the region.	2

Unit III: Ethnobotany in Modern Medicine : 6 Hours

Topic	Subtopics	Teaching Scope	Hours
1. Role of Ethnobotany in modern Medicine		- Drug discovery, Pharmacological validation, Integrative healthcare, Culturally sensitive care, Biodiversity conservation, Knowledge preservation	2
2. Medico-ethnobotanical sources in India	Classical literature	- Atharvaveda, **Caraka Saṃhitā, Suśruta Saṃhitā,** and **AṣṭāṅgaHṛdaya**	2
	Tribal and folk medicine	- Living knowledge of tribal and rural communities. This includes village-based remedies, region-specific plant uses, and healer traditions passed orally across generations.	
3. Case studies of Ethnomedicine	*Rauvolfia serpentina* and antihypertensive research	- Research significance	2
	Withania somnifera in rejuvenative medicine.	- Research significance	
	Artemisia species in antimalarial research.	- Research significance	

Unit IV: Traditional Agriculture, Organic Farming, and Sustainability : 8 Hours

Topic	Subtopics	Teaching Scope	Hours
1. Traditional Agriculture Systems in India	- Indigenous farming practices	- Highlight sustainable traditional practices	3
	Crop rotation, mixed cropping	- Discuss crop combinations and rotations	
	Seasonal farming calendars (Panchanga based)	- Connect to lunar/seasonal calendars	
2. Organic Farming and Soil Management in IKS	Use of cow dung, urine, compost	- Explain organic inputs from traditional sources	3
	Traditional biopesticides and fertilizers	- Discuss natural pest management	
	Kunapa Jala: Ancient Organic Liquid Fertilizer	**-** Definition, Composition, Preparation method, Modern validation, Applications	
	Seed Treatment and Germination Enhancement	- Explain Traditional seed coatings (Cow dung, ash, honey, clarified butter) - Seed sovereignty: Traditional seed storage and conservation techniques. - Desi seeds: Indigenous crop varieties and genetic diversity preservation.	

3. Sustainable Use of Plant Resources	Concept of "Sharing of Wealth" in IKS	- Discuss philosophical basis of sustainability	2
	Conservation through cultural practices	- Show how culture aids conservation	
	Eco-friendly plant use	- Link to current environmental challenges	

Suggested Readings and References:

Primary Texts

1. Jog D. & Pathak, H. (Eds.). *Ethnobotany of India* (Vol. 1–5).
2. Collet, S. (2019). *Medicinal Plants of India: An Ethnobotanical Perspective*.
3. Govindaraju, D. (2012). *Ayurveda and Modern Science: A Bridge*.
4. National Biodiversity Authority (NBA). *Guidelines on Documentation of Traditional Knowledge*.
5. Ministry of AYUSH. *Authentic Texts on Medicinal Plants and Ayurveda*.

Secondary Books & Articles

1. Jain, S. K. (1998). *Dictionary of Indian Folk Medicine and Ethnobotany*.
2. Bharati, V. R. (2006). *Traditional Knowledge Systems in India*.
3. FAO & INDGIR. *Traditional Agriculture and Sustainable Farming in India*.
4. UGC–NEP 2020 Guidelines on IKS Integration in Higher Education.
5. Recent articles from *Journal of Ethnobotany and Ethnozoology*, *Indian Journal of Traditional Knowledge*.
6. https://www.gdcplnr.edu.in/admin/uploads/73762703BSc_Botany Syllabus.pdf
7. https://xaviers.ac/main/images/syllabi/science/BotSem5.pdf
8. https://www.hnbgu.ac.in/sites/default/files/2022-09/Curricular_Framework_and_Syllabus_B_Sc_Botany_NEP_2020_1-4_semesters_FINAL. 09.09.22.pdf
9. https://www.suniv.ac.in/docs/NEP-2020-Botany-UG-syllabus.pdf
10. https://rnlkwc.ac.in/pdf/syllabus/poco/Botany NEP-2024_1st and second semester.pdf
11. https://dspmuranchi.ac.in/pdf/Syllabus/NEP_Botany.pdf
12. https://www.hnbgu.ac.in/sites/default/files/2024-02/Syllabus of B.Sc_. Botany as per NEP 2020.pdf
13. https://cdnbbsr.s3waas.gov.in/s39ed9328611fe3f45b3cce8ffe386ee97/uploads/2025/03/202503181256578029.pdf
14. https://gourmaha.ac.in/wp-content/uploads/2024/02/UG-BOTANY-SYLLABUS-sem-I-to-IV-NEP-2020_compressed.pdf
15. https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/faculty-of-science-and-technology/bsc-in-botany.pdf
16. https://www.ycis.ac.in/botany/syllabus/B. Sc. I Botany Syllabus.pdf
17. https://www.suniv.ac.in/docs/Botany-Syllabus.pdf
18. https://www.gscgandhinagar.in/includes/pdf/major-b-sc-botany-20240629063301.pdf
19. http://scott.ac.in/wp-content/uploads/2024/08/B-Sc-Botany.pdf
20. https://www.hnsbscihmt.org/upload/programs/1702375802bsc.pdf
21. https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/1/PG_M.Sc._Botony_346 12_Plant Taxonomy_MSc Botany.pdf
22. https://egyankosh.ac.in/bitstream/123456789/57292/1/Unit-11_CRC_Formatted.pdf
23. https://www.drishtiias.com/pdf/1657786241_BOTANY_Final.pdf
24. https://egyankosh.ac.in/bitstream/123456789/59071/1/Block-3.pdf
25. https://jtfp.jntbgri.res.in/index.php/jtfp/article/download/23/23/43
26. https://ggpgcs.com/files/syllbus/4year/BScIV/BotanyAP1D.pdf
27. https://sgbau.ac.in/Syllabus-Curriculum(CBCS)2022-23/BOT BSCIII Sem V and VI CBCS SYLLABUS 2024_25_12072024 (1).pdf
28. https://uni-mysore.ac.in/english-version/sites/default/files/content/botany_ug.pdf
29. https://www.mhescollege.ac.in/static/docs/academics/departments/botany/programmes-offered/syllabus/bsc-botany-syllabus.pdf
30. https://www.du.ac.in/uploads/Administration/AC/10072015/Annexure/10072015_Annexure-76.pdf
31. https://uok.ac.in/syllabus/1579_B.Sc. Botany Semester-V, VI.pdf
32. https://www.stphilos.ac.in/wp-content/uploads/2021/01/Botany-CBCS-syllabus-2018-2019-1.pdf
33. https://www.keralauniversity.ac.in/downloads/1botany_core_syllabus.pdf

34. https://bookauthority.org/books/best-general-and-reference-books
35. https://www.lesswrong.com/posts/HLJMyd4ncE3kvjwhe/the-best-reference-works-for-every-subject
36. https://nopr.niscpr.res.in/bitstream/123456789/66849/1/ALIS Vol.72(4) 370-380.pdf
37. https://books.iaph.in/wp-content/uploads/2023/02/the-basic-handbook-of-indian-ethnobotany-and-traditional-medicine-vol.-1-contents.pdf
38. https://www.vivekanandcollege.ac.in/uploads/naac/other/iks book final.pdf
39. https://www.jetir.org/papers/JETIR2502154.pdf
40. https://books.iaph.in/wp-content/uploads/2026/03/full-book-with-cover.pdf
41. https://books.google.com/books/about/Medicinal_Plants_of_India_Vol_1.html?id=VaGMDwAAQBAJ
42. https://archive.org/details/Vrikshayurveda
43. https://www.barnagarcollege.ac.in/upload/notice/1647944749.pdf
44. https://chowkhambasanskritseries.com/product/vrikshayurveda-bas-64
45. https://www.lesswrong.com/posts/xg3hXCYQPJkwHyik2/the-best-textbooks-on-every-subject
46. https://books.iaph.in/wp-content/uploads/2026/03/0-The-Basic-Handbook-of-Indian-Ethnobotany-and-Traditional-Medicine-vol2-TOC.pdf
47. https://kew1beans.wordpress.com/2014/12/07/420/
48. https://www.scribd.com/doc/178915886/List-of-recommended-textbooks-pdf
49. https://www.openculture.com/free_textbooks
50. https://guides.lib.umich.edu/c.php?g=282871&p=6557089
51. https://sanyamkapoor.com/kb/textbooks-on-various-subjects/
52. https://cs.uwaterloo.ca/~alopez-o/math-faq/mathtext/node43.html
53. https://openstax.org/subjects/

Question Paper Pattern
B. Sc. Semester V
Subject: IKS in Botany – I

Time: 2 Hours | Maximum Marks : 40

Que 1. Short Answer Questions **04 Que. X 02 Marks = 08 Marks**
A) Unit I
B) Unit I
C) Unit I
D) Unit I

OR

Short Answer Questions
A) Unit II
B) Unit II
C) Unit II
D) Unit II

Que 2. Short Answer Questions **04 Que. X 02 Marks = 08 Marks**
A) Unit III
B) Unit III
C) Unit III
D) Unit III

OR

Short Answer Questions
A) Unit IV
B) Unit IV
C) Unit IV
D) Unit IV

Que 3. Multiple Choice Questions **08 Que. X 01 Mark = 08 Marks**
1) Unit I
2) Unit I
3) Unit I
4) Unit I
5) Unit I
6) Unit I
7) Unit I
8) Unit I

OR

Multiple Choice Questions
1) Unit II
2) Unit II
3) Unit II
4) Unit II
5) Unit II
6) Unit II
7) Unit II
8) Unit II

Que 4. Multiple Choice Questions **08 Que. X 01 Mark = 08 Marks**
1) Unit III
2) Unit III
3) Unit III
4) Unit III
5) Unit III
6) Unit III
7) Unit III
8) Unit III

OR

Multiple Choice Questions
1) Unit IV
2) Unit IV
3) Unit IV
4) Unit IV
5) Unit IV
6) Unit IV
7) Unit IV
8) Unit IV

Qu. 5 Answer in One-Two Sentences (Attempt any *Eight*) 08 Que. X 01 Mark = 08 Marks

a) From Unit I
b) From Unit I
c) From Unit I
d) From Unit II
e) From Unit II
f) From Unit II
g) From Unit III
h) From Unit III
i) From Unit III
j) From Unit IV
k) From Unit IV
l) From Unit IV

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