Sant Gadge Baba Amravati University

Amravati

Scheme of Teaching, Learning & Examination

Leading to the Degree in Bachelor of Science in the Programme

Botany

In the Faculty of Science and Technology

(Three years - Six Semester Degree Programme - C.B.C.S.)

B.Sc. Part III

Semester V and Semester VI

Session 2024 – 2025 Onwards

Sant Gadge Baba Amravati University, Amravati
Examinations leading to the Degree of Bachelor of Science
Three Years (Six Semesters) Degree Programme under Choice Based Credit System (CBCS)

Scheme of Teaching, Learning, Examination and Evaluation (B.Sc. - Botany) (Semester-V)

Sr. No	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exams	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits			Hrs.	Maximum Marks					Minimum Passing	
			L	T	P	Total	Theory/ Tutorial	Practical	Total		Theory + M.C.Q Ext.	Skill Enhancement Module (SEM) Int.	Practical		Total Marks	Marks	Grade
													Internal	External			
1	DSC V: Biochemistry, Plant Physiology and Ecology	BOT 5S	6	-	-	6	4.5	-	4.5	3	80	20	-	-	100	40	P
2	Lab	BOT 5S PR	-	-	6	6	-	2.25	2.25	3	-	-	25	25	50	25	P
3	Mini-Project/Hands-on Training/Workshop/DIY related to Botany			-	6	6	--	2.25	2.25	2	Internal Assessment by college/institute/department				50	25	P
4	*Open Elective Course (OEC) **GIC: BOT(5S) (GIC-4) Forensic Botany (Optional)**	BOT 5S GIC-4					75 hrs (during session) optional to extracurricular and co-curricular activities										
5	Internship/Apprenticeship/Field Work/Work Experience						150 Hours cumulatively from Sem II to Sem V resulting into earning of 5 Credits (Minimum 120 Hours mandatory resulting into earning of 4 Credits)										

L: Lecture, T: Tutorial, P: Practical, DIY: Do It Yourself activity

Notes :

1. Internship/Apprenticeship/Field Work/Work Experience is Mandatory. It can be carried out cumulatively from Semester I to Semester V for a duration of 150 Hours resulting into earning of 5 Credits (Minimum 120 Hours resulting into earning of 4 Credits is mandatory for every student). Internship /Apprenticeship/Field Work / Work Experience will be conducted after I semester till Vth semester in vacations for minimum 120 hrs, cumulatively entailing 4 Credits. It's credits and grades will be reflected in final semester VI credit grade report.
2. Teaching period in the various subjects in the faculty of science shall be as prescribed by the executive council dated 1/2-4-1977, 11-7-1977 Appendix- P
3. If DSC (excluding Mathematics) is Physics, then 2 Tutorial be added.
4. There shall be Skill Enhancement Module (SEM) in each course of DSC and DSE
5. OEC (Optional) can be studied during semester I to V, Its credits and grades will be reflected in final semester VI credit grade report. OEC may be opted from Sem I to Sem V. It is comprised of GIC, Skill Course and MOOC (through SWAYAM)
6. Minimum 10% of the total credits of the UG (Bachelor's Degree) programme, that is, at least 12 credits are mandatory to be earned by all the students from Ancillary Credit Courses as mentioned in Table A (SGBAU, Direction No. 76/2022 ,Date 06/10/2022)
7. Extra-curricular and co-curricular activities: Maximum 5 Credits may be earned through Extra-curricular and co-curricular activities, which will be an option to OEC (maximum 75 hours and 5 credits), so that students performing in such activities shall be given exemption from undertaking

Sant Gadge Baba Amravati University, Amravati
Faculty: Science and Technology Programme: B.Sc. (Botany)
Syllabus Prescribed for Three Year UG Programme: B.Sc. Semester- V

Code of the Course/Subject	Title of the Course/Subject	(Number of Periods per week)
BOT(5S) /Botany	Biochemistry, Plant Physiology, and Ecology	6

Course Outcomes:

1. **CO1: Understand Fundamental Plant Processes**
   Upon completion of this course, students will be able to describe and explain the fundamental physiological processes in plants, including water relations, mineral uptake, photosynthesis, respiration, and plant growth and development, demonstrating knowledge of basic concepts and terminology.

2. **CO2: Analyze Biochemical and Molecular Mechanisms**
   Students will be able to analyze and articulate the biochemical and molecular mechanisms underlying plant physiology, including enzyme action, biomolecule functions, and the intricacies of photosynthesis and respiration pathways.

3. **CO3: Apply Knowledge to Environmental and Ecological Contexts**
   Learners will apply their understanding of plant physiology and biochemistry to environmental and ecological contexts, assessing the impacts of environmental factors on plant processes and evaluating plant adaptations to various ecosystems.

4. **CO4: Evaluate Plant Responses and Adaptations**
   Students will evaluate and critically assess plant responses to biotic and abiotic stresses, including mechanisms of senescence, abscission, and stress physiology, and propose strategies for mitigating adverse environmental impacts.

5. **CO5: Synthesize Concepts Across Disciplines**
   Participants will synthesize concepts from plant physiology, biochemistry, ecology, and environmental science to develop integrated approaches to studying plant life, demonstrating the ability to draw connections between theory and practice in Botany.

6. **CO6: Design and Conduct Experiments**
   Upon course completion, students will be competent in designing and conducting experiments related to plant water relations, metabolism, growth, responses to environmental stimuli, and ecological interactions, reflecting an ability to create new knowledge or solutions in the field of Botany.

Curriculum

For the Semester V Botany subject will be taught through DSC-V and Skill Enhancement Module. DSC-V is the course which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

Whereas, **Any One of the Skills Enhancement Modules (SEM) prescribed** shall have 20% weightage in the total curriculum of the subject. These skill modules shall be based on Learning Outcome of the course and shall be used for continuous evaluation of the students. These modules will be internally assessed flexibly on the basis of Class tests, assignments, seminar, reading material, project, survey, group discussion, Study tour, MCQ, Open Book exam (OBE), etc. Marks shall be sent in the format prescribed by the University from time to time.

Unit	Content	Lectures Req: 78
Unit-I	**Biochemistry and Metabolism** **1.1 Biomolecules:** Structures and functions of glucose, sucrose, starch, cellulose, and lipids. **1.2 Enzymes:** Concepts, properties, nomenclature, mechanism of action including lock and key model, induced fit theory. **1.3 Water:** Properties of water, diffusion, osmosis, plasmolysis, imbibition. **1.4 Absorption of Water:** Mechanisms of active and passive absorption, root pressure, transpiration pull.	13
Unit -II	**Plant Water Relations, Mineral uptake and Photosynthesis** **2.1 Transpiration:** Types, stomatal movements, mechanisms, significance, antitranspirants, guttation. **2.2 Mineral Uptake:** Mechanisms of active and passive uptake, ion exchange and carrier concept. **2.3 Photosynthesis- Light Reaction:** Photosynthetic apparatus and pigments, light reactions, photophosphorylation. **2.4 Photosynthesis- Dark Reaction:** C3, C4 pathways, CAM pathway, significance of photosynthesis.	13
Unit -III	**Metabolism and Growth** **3.1 Respiration:** Aerobic and anaerobic respiration, glycolysis, Krebs cycle, electron transport system (ETS), ATP generation. **3.2 Nitrogen Metabolism:** Nitrogen sources, biological nitrogen fixation. **3.3 Growth:** Growth phases, growth curves. **3.4 Plant Hormones:** Physiological roles of auxins, gibberellins, cytokinins, abscisic acid, ethylene.	13
Unit –IV	**Plant Responses** **4.1 Physiology of Flowering:** Photoperiodism, florigen, phytochromes, vernalization. **4.2 Physiology of Senescence and Abscission:** Mechanism and Hormonal regulation **4.3 Plant Movement:** Tropic and nastic movements. **4.4 Stress Physiology:** Water and Salinity stress.	13
Unit –V	**Ecology and Environment** **5.1 Ecology and Environment:** Concepts, ecological factors including climatic and edaphic, soil formation, soil profile. **5.2 Atmosphere:** Layers, Composition and Conditions **5.3 Ecological Adaptations:** Adaptations in Hydrophytes and Xerophytes. **5.4 Population Ecology:** Concepts and Dynamics of Natality, Mortality.	13
Unit -VI	**Community ecology and Ecosystem** **6.1 Community Characteristics:** Qualitative and quantitative characteristics, including physiognomy, phenology, life forms, biological spectrum, frequency, density, abundance. **6.2 Community Dynamics:** Succession causes, types (Hydrosere, Xerosere). **6.3 Ecosystem:** Structure, types (pond, forest ecosystems). **6.4 Ecosystem Functions:** Food chain, food web, ecological pyramids, energy flow.	13

SEM (SKILL ENHANCEMENT MODULE) SEMESTER V

Any One of the Following (Teaching Hours: 12 and Practical Sessions:03; ; Marks: 20)

A. PHYTOCHEMISTRY –

CO's

After completion of this course successfully, the students would be able to

1. Understand the fundamental concepts of phytochemistry
2. Acquire skill in analysis of secondary metabolites in plant material

Content-

1.1 Methods of plant sample Collection and drying
1.2 Primary metabolites - Concept and application of Nucleic Acid, Proteins, Carbohydrates, Hormones
1.3 Secondary metabolites- Concept and application of Alkaloids, Phenolics, saponins and Flavonoids.
1.4 Networking of the Primary and Secondary Metabolite

Activities –

1. Plant Sample collection and drying
2. Diagrammatic representation of Biosynthesis of Primary metabolites
3. Hands on training for detections of Secondary metabolites
4. Report submission on phytochemical analysis

B. STRESS BIOLOGY –

CO's

After completion of this course successfully, the students would be able to

1. Understand the concept of stress
2. Experts in identification of crop plants under stress conditions

Content-

1.1 Fundamentals of Plant Stress Biology

A. Introduction to Stress Biology
B. Cellular Responses
C. Molecular Responses

1.2 Abiotic Stress: Responses and Adaptations

A. Temperature and Water Stress
B. Salinity and Heavy Metals
C. Strategies of plants use to cope with saline environments and heavy metal toxicity, including ionic balance and detoxification mechanisms.

1.3 Biotic Stress: Interactions and Defenses

A. Pathogens and Herbivory
B. Genetics and Hormonal Regulation, Genetic basis of biotic stress tolerance
C. Role of phytohormones (e.g., ABA, Ethylene) in modulating stress responses.

1.4 Applied Stress Biology and Future Perspectives

A. Ecological and Agricultural Implications
B. Technological Innovations and Case Studies
C. Current Research and Future Directions

Activities-

1. Survey and collection of crop plants under stress conditions from local fields
2. Simulation of Abiotic and Biotic Stress
3. Diagnosis/ identification of stress condition on the basis of specific symptoms and submission.
4. Submission of report with photographic evidence.

C. VEGETATION MAPPING-

CO's

After completion of this course successfully, the students would be able to

1. Understand the vegetation mapping techniques
2. Acquire skill in evaluation of vegetation dynamics,
3. Analyze variations and distribution of vegetation.

Content-

3.1- Community characteristics –qualitative and quantitative
3.2. Field Sampling methods Community study by quadrate methods
3.3. Species Area curve for minimum quadrat size, Minimum quadrat number
3.4. Parameters of Vegetation description and structure

Activities

1. Plant Community Study of College Campus/ nearby area
2. Calculation of Shannon, Simpson, and other diversity indices using collected data.
3. Life forms study of nearby area
4. Submission of report

Sant Gadge Baba Amravati University, Amravati Syllabus
Prescribed for Three Year UG/PG Programme
B.Sc. Semester V

Practical Semester – V: Biochemistry, Plant Physiology, and Ecology

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands- on/Activity)	(No. of Periods/Week)
BOT(5S)/Botany	**Biochemistry, Plant Physiology, and Ecology**	**02**

COs

By the end of the Lab/Practical Course, generally students would be able to:

1) Understand the physiological process
2) Acquire the skill for detection of biomolecule and ecological adaptations
3) Classify and identify different metabolic process
4) Describe the ecological adaptations and vegetation

***LIST OF PRACTICAL /LABORATORY EXPERIMENTS/ACTIVITIES ETC.**

I. BIOCHEMISTRY (Any TWO)

1. To demonstrate test of glucose / sucrose
2. To demonstrate test for starch
3. To demonstrate test for cellulose
4. To study the activity of enzyme catalase
5. To demonstrate test for lipid

II. PLANT PHYSIOLOGY

Major experiment (Any THREE)

1. To study the effect of temperature and organic solvent on permeability of plasma membrane.
2. To study osmotic pressure of cell sap by plasmolytic method.
3. To determine water potential of plant tissue.
4. To determine the rate of transpiration by Ganong's potometer.
5. To determine rate of photosynthesis under varying quality and CO2 concentration by using Willmott's bubbler.
6. To study the rate of photosynthesis in terrestrial plants with the help of Ganongs photosynthometer.
7. Separation of chloroplast pigments by solvent / paper chromatography method.
8. To determine R.Q. using different substrates.
9. To determine the the rate of respiration by Ganongs respirometer.
10. To study antagonism of salts.
11. To determine the path of water (ascent of sap)
12. To study phenomenon of adsorption.
13. Effect of IAA and Gibberellins on seed germination.

Minor experiment- (Any THREE)

1. To demonstrate fermentation.
2. To demonstrate osmosis by potato osmoscope / egg osmoscope..
3. To demonstrate transpiration by Bell jar.
4. To demonstrate anaerobic respiration in germinating seeds.
5. To demonstrate the evolution of CO2 in respiration.
6. To demonstrate the phenomenon of nastic movement with help of *Mimosa pudica* / or *Biophytum sensitivum*

III. ECOLOGY

Major Experiments (Any TWO)

1. Study of morphological and anatomical adaptations in hydrophytes – *Hydrilla*, *Eichhornia*, *Typha* and *Nymphaea* (Any two).
2. Study of morphological and anatomical adaptations in xerophytes -Asparagus, Nerium, Casuarina, Cycas and Opuntia. (Any two).
3. To study community characteristics by quadrate methods
4. Determination of water holding capacity of different soils.
5. Determination of soil texture by sieve method

Minor Experiment (Any TWO)

1. To determine the porosity of soil.
2. To determine the transparency of water.
3. Estimation of salinity of different water samples
4. Determination of pH of different soils and water samples by pH papers/ pH meter.
5. Study of meteorological instruments -Rain gauge, Hygrometer, Barometer

Practical Evaluation Semester V

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER V – (CBCS New)
Practical – V Biochemistry, Plant Physiology and Ecology

Duration – Continuous Evaluation **Marks-25**

Q.No.	Internal Practical Examination	Marks-25
1	Attendance (Entire Semester)	05
2	Performance and Participations in conduct of the practical for Entire Semester - (Plant physiology, Biochemistry & Ecology)	09
3	**Activity participation and Report:** Academic/Institute/Industrial/Field visit or any report activity related to the subject	03
4	Practical Record Book	05
5	Internal Viva-Voce	03

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER V – (CBCS New)
Practical: Biochemistry, Plant Physiology and Ecology

Time – 4 Hours **Max Marks-25**

Q.No.	External Practical Examination	Marks-25
1	Plant physiology – Major	07
2	Plant physiology – Minor	03
3	Biochemical Test (Any one)	03
4	Plant Ecology – Major	07
5	Plant Ecology – Minor	03
6	External Viva-Voce	02

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER V – (CBCS New)
SKILL ENHANCEMENT MODULE

Duration – Continuous Evaluation **Max Marks-20**

Q.No.	Criteria of Assessment	Marks-20
1	Attendance for SEM Classes and Activities	5
2	MCQ Assessment	5
3	Activity Report	5
4	Internal Viva-Voce	5

Course Material/Learning Resources

Textbooks and Reference Books

1. Anasane, P. Y., Dagwal, M. J., Kanherkar, U. R., Gopekar, N. S., & Deshmukh, O. S. (2018). A Textbook of Botany B.Sc. Fifth Semester Plant Physiology and Ecology. DnyanPath Publication.
2. Botkin, D.B., & Keller, E.A. (2000). Environmental science: Systems and solutions (2nd ed.). John Wiley & Sons, Inc.
3. Buchanan, B.B., Gruissem, W., & Jones, R.L. (2000). Biochemistry & molecular biology of plants. [Publisher].
4. Chapman, J.L., & Reiss, M.J. (1995). Ecology: Principles and applications. Cambridge University Press.
5. Chaudhari, M.A., & Gupta, K.K. (2009). Practical plant physiology. New Central Book Agency Ltd.
6. Cunningham, W.P., & Saigo, B.W. (1997). Environmental science: A global concern. McGraw-Hill.
7. Curtis, H., & Clark, N. (Year). Introduction to plant physiology. [Edition]. [Publisher].
8. Dash, M.C. (1993). Fundamentals of ecology. Tata McGraw-Hill Publishing Co. Ltd.
9. Dennis, D.T., Turpin, D.H., Lefebvre, D.D., & Layzell, D.B. (Eds.). (1997). Plant metabolism (2nd ed.). Longman.
10. Devlin, R.M. (Year). Plant physiology. [Edition]. [Publisher].
11. Galston, A.W. (1989). Life processes in plants. Scientific American Library/Springer-Verlag.
12. Harper, C., Varma, S.K., & Verma, M. (2014). Plant physiology, biochemistry and biotechnology (4th ed.). S Chand Publication.
13. Hopkins, W.G. (1995). Introduction to plant physiology. John Wiley & Sons, Inc.
14. Hopkins, W.G., & Huner, N.P.A. (2008). Introduction to plant physiology. John Wiley & Sons.
15. Jain, V.K. (Year). Fundamentals of plant physiology. S. Chand Publication.
16. Kochhar, S.L., & Gujjar, S.K. (2020). Plant physiology: Theory and applications. Cambridge Publications.
17. Kumar, H.D. (1996). Modern concepts of ecology (3rd ed.). Vikas Publishing House Pvt. Ltd.
18. Lincoln, T., & Zeiger, E. (2003). Plant physiology (3rd ed.). Panima Publishing Corporation.
19. Mayer, A., & Anderson, J.B. (1952). Plant physiology. Digitized Edition 2009. Van Nostrand.
20. Miller, W.R., & Donahue, R.L. (1992). Soils: An introduction to soils and plant growth (6th ed.). Prentice Hall of India Pvt. Ltd.
21. Mohr, H., & Schopfer, P. (1995). Plant physiology (4th ed.). Wordsworth.
22. Moore, T.C. (1989). Biochemistry and physiology of plant hormones. Springer-Verlag.
23. Salisbury, F.B., & Ross, C.W. (1992). Plant physiology (4th ed.). Wadsworth Publishing Company.
24. Sharma, P.D. (2003). Ecology and environment. Rastogi Publications.
25. Singh, A. (1967). Plant physiology. Asia Publishing House.
26. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D., & Govindjee. (1999). Concepts in photobiology: Photosynthesis and photomorphogenesis. Narosa Publishing House.
27. Smith, L.R., & Smith, T.M. (1998). Elements of ecology (4th ed.). An imprint of Addison Wesley Longman, Inc.
28. Taiz, L., & Zeiger, E. (1998). Plant physiology (2nd ed.). Sinauer Associates, Inc. Publishers.
29. Tyler, M.G., Jr. (1997). Environmental science: Working with Earth (6th ed.). Wadsworth Publishing Co.
30. Verma, S.K., & Verma, M. (2007). A textbook of plant physiology, biochemistry and biotechnology. S. Chand Publishing.
31. Weaver, J.E., & Clements, F.E. (1966). Plant ecology. Tata McGraw-Hill Publishing Co. Ltd.

Sant Gadge Baba Amravati University, Amravati
Syllabus Prescribed for Three-Year UG Programme
Programme: B.Sc. III
Semester V (CBCS Scheme)

General Interest Course (GIC) for Semester V

Code of the Course/Subject	Title of the Course/Subject	Total Number of Period
BOT(5S)/Botany (GIC-4)	Forensic Botany	30

Course Outcomes:

CO 1: Understanding of Forensic Botany (Understanding): Grasp the fundamentals of forensic botany, its history, and role in crime investigations.
CO 2: Appreciation of Historical Cases & Applications (Comprehension & Analysis): Analyze and relate the historical progression and relevance of botanical forensics to real-world cases.
CO 3: Proficiency in Botanical Evidence Analysis (Application & Analysis): Apply knowledge to identify and assess various forms of botanical evidence.
CO 4: Awareness of Plant-derived Substances & Legal Restrictions (Knowledge & Comprehension): Identify key poisonous plants and botanical drugs and comprehend their legal implications.
CO 5: Expertise in Plant Ecology & Botanical Evidence Types (Analysis & Synthesis): Distinguish and synthesize types of botanical evidence and their significance in forensic investigations.
CO 6: Career Awareness & Opportunities (Evaluation): Evaluate career pathways in forensic botany and determine potential future pursuits.

Detailed Curriculum

Unit	Detail Description / Content	Periods require
Unit - I:	1.1 Course introduction, expectations, History and Development of Forensic Science in India and World. 1.2 Forensic Botany: Definition and scope Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. Cell: Definition, Classification and Significance of Cells in Forensic Science. 1.3 Brief historical excursion about the application of botanical knowledge to forensic investigation. From the "Crime of the Century" (kidnapping of Charles Lindbergh Jr.) to cases of murder, war crimes, and legal disputes concerning plants subjected to legal restrictions. Civil vs. criminal forensic botany (Any One Case Study) 1.4 Sources of forensic evidence: palynology, dendrology and dendrochronology, limnology, plant anatomy, plant ecology, and identification of plant portions or remnants. 1.5 Elements of molecular biology applied to plants.	15
Unit - II:	2.1 Essential parts of plants, Plant as evidence 2.2 Common poisonous plant and types of plant toxins. Poisonous plants and botanical drugs: marijuana and hashish (*Cannabis sativa)*, cocaine (*Erytroxylum coca*), opium (*Papaver somniferum*). 2.3 New psychoactive substances (NPS). Plant-derived "Smart drugs" (natural and ethnic drugs), classification and examples (Absinthe, Areca nut, *Salvia divinorum*, *Catha edulis*, *Ipomoea* spp., etc.), Historical uses and toxicity. Overview of legal restrictions. 2.4 Application of Forensic Botany, 2.5 Careers in Forensic Biology	15

Course Material/Learning Resources

Textbooks and Reference Books

1. Chowdhuri, Forensic Biology, BPRD, New Delhi (1971).
2. Saferstein, Forensic Science Handbook, Vol. III, Prentice Hall, New Jersey (1993).
3. Forensic Botany: A Practical Guide 2nd Edition, Kindle Edition by David W. Hall (Author), Jason Byrd (Author) Format: Kindle Edition
4. Nanda, B.B. & Tiwari, R.K.; Forensic science in India- A vision for the twenty first century, Select Publisher, New Delhi (2001)
5. J.A. Seigel, R.J Sukoo and G.C Knupfer; Encyclopaedia of Forensic Science vol. I, II& III, Academic Press (2000)
6. Sharma, B. R., Forensic Science in Criminal Investigation and Trials (3rd Ed) Universal Law Publishing Co. Ltd. New Delhi, 2001.
7. Coyle, Heather Miller, ed. *Forensic botany: principles and applications to criminal casework*. CRC Press, 2004.
8. Smart drugs - seconda edizione. Simona Pichini et al. .Dipartimento del Farmaco - Osservatorio Fumo Alcol e Droga Istituto Superiore di Sanità - 2010. Centro Stampa De Vittoria srl. Roma. http://www.iss.it/binary/drog/cont/SD_COMPLETO_ridotto.pdf
9. Lesson slides as pdf files available online at the "AulaWEB" internet site.

Pedagogy

Class lessons, meetings with experts, observations of forensic plant samples with the Scanning Electron Microscope (SEM).

Sant Gadge Baba Amravati University, Amravati

Scheme of Teaching, Learning & Examination leading to the Degree in Bachelor of Science in the Programme Botany in the Faculty of Science and Tech.

(Three years- Six Semester Degree Programme- C.B.C.S.) (B.Sc. Part III) Semester VI

Sr.	Subject	Subject code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	T/T	Practical	Total		Theory+ MCQ External	Skill Enhancement Module	Internal	External		Marks	Grade
1	**DSE - I:** Molecular Biology and Plant Biotechnology **OR** **DSE - II:** Plant Diversity and Systematics	BOT 6S	6	-	-	6	4.5	-	4.5	03	80	20	-	-	100	40	P
2	Lab **DSE - I:** Molecular Biology and Plant Biotechnology **OR** **DSE - II:** Plant Diversity and Systematics	BOT 6S PR	-	-	6	6	-	2.25	2.25	04	-	-	25	25	50	25	P
	Mini-Project/Hands-on Training/ Workshop/DIY related Botany				6	6	-	2.25	2.25	02	Internal Assessment by college/institute/department				50	25	P
3	BOT(6S) (GIC-5) AI in Botany (Optional)	BOT 6S GIC-5	1														

L: Lecture, T: Tutorial, P: Practical, DIY: Do It Yourself activity

Notes:

1. **Internship/Apprenticeship/Field Work/Work Experience is Mandatory.** It can be carried out cumulatively from Semester I to Semester V for a duration of 150 Hours resulting into earning of 5 Credits **(Minimum 120 Hours resulting into earning of 4 Credits is mandatory for every student).** Internship /Apprenticeship/Field Work / Work Experience will be conducted after I semester till Vth semester in vacations for minimum 120 Hrs, cumulatively entailing 4 Credits. It's credits and grades will be reflected in final semester VI credit grade report.
2. **Teaching period in the various subjects in the faculty of science shall be as prescribed by the executive council dated 1/2-4-1977, 11-7-1977 Appendix- P**
3. **If DSC (excluding Mathematics) is Physics, then 2 Tutorial be added.**

4. There shall be Skill Enhancement Module (SEM) in each course of DSC and DSE
5. **OEC (Optional) can be studied during semester I to V, Its credits and grades will be reflected in final semester VI credit grade report.** OEC may be opted from Sem I to Sem V. It is comprised of GIC, Skill Course and MOOC (through SWAYAM)
6. **DSE (DISCIPLINE/DEPARTMENT SPECIFIC ELECTIVE): A BASKET CONTAINING AT LEAST TWO COURSES/SUBJECTS SHALL BE PROVIDED, SO THAT STUDENT HAS A CHOICE FOR THE SELECTION.**
7. Minimum 10% of the total credits of the UG (Bachelor's Degree) programme, that is, at least 12 credits are mandatory to be earned by all the students from Ancillary Credit Courses as mentioned in Table A (SGBAU, Direction No. 76/2022, Date 06/10/2022)
8. **Extra-curricular and co-curricular activities**: Maximum 5 Credits may be earned through Extra-curricular and co-curricular activities, which will be an option to OEC (maximum 75 hours and 5 credits), so that students performing in such activities shall be given exemption from undertaking OEC.

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Three-Year UG Programme

Programme: B.Sc. III

Semester VI (CBCS Scheme)

For the Semester VI Botany subject will be taught through Elective Papers of individual choice in DSE – I and DSE – II and Skill Enhancement Module. DSE are the courses from which one must be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

Whereas, **Any One of the Skills Enhancement Modules (SEM) prescribed** shall have 20% weightage in the total curriculum of the subject. These skill modules shall be based on Learning Outcome of the course and shall be used for continuous evaluation of the students. These modules will be internally assessed flexibly on the basis of Class tests, assignments, seminar, reading material, project, survey, group discussion, Study tour, MCQ, Open Book exam (OBE), etc. Marks shall be sent in the format prescribed by the University from time to time.

DSE I: Molecular Biology and Plant Biotechnology

Code of the Course/Subject	Title of the Course/Subject	Total Number of Period
DSE I: BOT(6S)/Botany	Molecular Biology and Plant Biotechnology	72

Course Outcomes:

1. **CO1: Understanding the Molecular Foundation of Life**
Students will demonstrate foundational knowledge of DNA as the genetic material, including its discovery, structure, and the key historical experiments that established its role in heredity. They will understand the basic concepts of gene structure, expression, and regulation in both prokaryotes and eukaryotes.

2. **CO2: Mastering Gene Expression and Regulation**
Students will apply their understanding of DNA replication, packaging, and the central dogma of molecular biology to explain gene expression and regulation. They will demonstrate the ability to use this knowledge in understanding the mechanisms of transcription and translation in eukaryotes.

3. **CO3: Proficiency in Recombinant DNA Technology**
Students will analyze the processes involved in recombinant DNA technology, including the use of restriction enzymes, cloning vectors, and gene transfer techniques. They will be able to dissect the steps of PCR and explain the significance of each step in gene amplification.

4. **CO4: Exploring Plant Tissue Culture**
Students will develop practical skills in plant tissue culture and recombinant DNA technology. They will apply aseptic techniques, media preparation, and understand the importance of cellular totipotency, differentiation, and morphogenesis in micropropagation.

5. **CO5: Applying Biotechnology in Agriculture and Industry**
Students will evaluate the regulatory mechanisms of gene expression, including the operon concept and gene expression in eukaryotes. They will critically assess the techniques and applications of plant biotechnology in agriculture, including the development and use of transgenic plants and synthetic seeds.

6. **CO6: Ethical, Environmental, and Social Implications**
Students will synthesize their knowledge and skills to propose innovative applications of plant biotechnology in agriculture, industry, health care, and conservation. They will debate the pros and cons of genetically modified organisms, considering ethical, ecological, and societal impacts.

Detailed Curriculum

Unit	Detail Description / Content	Periods require
Unit - I:	**DNA As the genetic Material:** 1.1 Historical account – Giffith's Experiment, Hershey & Chase Experiment, Avery, MacLeod, and McCarty Experiment 1.2 DNA– Discovery, Chemical composition and Structure (Double Helical Model) 1.3 DNA replication in Eukaryotes; 1.4 DNA Packaging - Nucleosome and Solenoid 1.5 Repetitive DNA, and Transposable element in plants (AC-DS system)	12
Unit - II:	**Gene Structure and Expression** 2.1 Concept of gene, Fine structure of Gene 2.2 Gene Expression – Central Dogma 2.3 Types of RNA, Genetic code 2.4 Transcription in Eukaryotes – Structure and Function of RNA Polymerase, Mechanism of Transcription and RNA Processing 2.5 Translation in Eukaryotes – Structural and Functional Aspects of Ribosome (Translation Machine)	12
Unit - III:	**Regulation of Gene Expression** 3.1 Regulation of Gene Expression in Prokaryotes – Operon concept with special reference to Lac Operon 3.2 Regulation of gene expression of Eukaryotes – Britton Davidson Model 3.3 Endomembrane system (Flow of Peptide) 3.4 Protein Structure and Folding Mechanism (Primary, Secondary, Tertiary, and Quaternary) 3.5 Protein Sorting and Trafficking – Targeting proteins for their destinations	12
Unit – IV:	**Recombinant DNA Technology** 4.1 Recombinant DNA technology: Process, Tools and Techniques 4.2 Restriction Enzymes – Nomenclature and Types 4.3 Cloning vectors – Plasmids, Phages, Cosmids 4.4 Gene Transfer Techniques – **Direct -** (1) Chemical method, (2) Electroporation, (3) Gene gun **Indirect –** Agrobacterium mediated gene transfer 4.5 Gene Amplification - Polymerase Chain Reaction (PCR)	12
Unit – V:	**Plant Tissue Culture –** 5.1 Introduction to Plant Tissue Culture, Plant Cell and Tissue Explants 5.2 Laboratory Design and Setup – Essential equipment and materials Aseptic techniques and their importance (Laminar Air Flow Cabinate, Autoclave, Growth Chamber), Sterilization Techniques 5.3 Media Preparation - Culture Media (MS Media), Growth Hormone (Auxin, Cytokinin and Gibberellins) 5.4 Cellular totipotency, differentiation and morphogenesis; Micropropagation 5.5 Callus Culture, Organ Culture, Haploid and Dihaploid Production	12
Unit – VI:	**Applications of Plant Biotechnology –** 6.1 Agriculture – Haploid plant production (Anther and Pollen Culture); Protoplast Culture and Somatic Hybridization; Transgenic Plant - BT Cotton, Synthetic Seed. 6.2 Salient achievements of crop biotechnology 6.3 Industry – Fermentation Technology- Bakery Products and Alcohol Productions. 6.3 Health Care – Edible Vaccines 6.4 Conservation – Cryopreservation, 6.5 Genetically Modified Organisms: -Pros and Cons	12

Sant Gadge Baba Amravati University, Amravati
Syllabus Prescribed for Three Year UG
Programme: B.Sc. III Semester VI

Practical Semester VI – DSE I Molecular Biology and Plant Biotechnology

Code of the Course/Subject	Title of the Course/Subject	(No.of Periods/week)
BOT (6S)/BOTANY	**Practical**	**2 Practicals per week**

1.	**Molecular Biology: Major (Any Three)** 1. Isolation of DNA by crude method 2. Estimation of DNA by Diphenylamine method 3. Estimation of RNA by Orcinol method 4. Modeling the Double Helical Structure of DNA using household materials 5. Graphical Simulation of the Operon Model of Gene Regulation **Molecular Biology: Minor (Any Three)** 1. Demonstration of Principal and Mechanism of DNA Electrophoresis, 2. Demonstration of Principal and Mechanism of Centrifugation 3. Demonstration of AC-DS System in Maize kernel using flash cards 4. Demonstration of the Process of the Transcription and Translation using model sequence of nucleotide 5. Demonstration of the Process of DNA Packaging using Beads and Strings explaining Nucleosome and Solenoid
2.	**Biotechnology Major Experiments (Any Three)** 1. Isolation of Protoplast by Mechanical Method 2. Isolation of Protoplast by Enzymatic Method 3. Preparation of Artificial Seed 4. Pollen viability test. 5. Preparation of Tissue culture media 6. Sterilization of Explant 7. Inoculation of Explant **Biotechnology Minor Experiments (Any Three)** 1. Working Principle and application of Autoclave 2. Working Principle and Application of Laminar Air Flow 3. Cleaning and Sterilization of Glassware 4. Demonstration of in vitro culture techniques – anther and pollen culture 5. Demonstration of the technique of Micropropagation 6. Demonstration of hardening of tissue culture plant

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER V – (CBCS New)
Practical – VI Molecular Biology and Plant Biotechnology

Duration – Continuous Evaluation **Marks-25**

Internal Practical Examination

1.	Attendance/ Active participation in Lab sessions, Regularity, etc	**5**
2.	Student performance - Seminar/ Group Discussion and other formative assessment related to the subject.	**5**
3.	Activity report- Academic /Institute/Industrial/Field visit or any report activity related to the subject.	**5**
4.	Class record	**5**
5.	Viva – voce (Internal Examiner)	**5**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER V – (CBCS New)
Practical – VI Molecular Biology and Plant Biotechnology

Time: 4 hrs. **Max. Marks: 25**

External Practical Examination

Q. 1 – Molecular Biology- Major experiment	7
Q. 2 – Molecular Biology Minor experiment	3
Q. 3 – Biotechnology Major Experiment	7
Q. 4 – Biotechnology- Minor Experiment	3
Q. 5 - Viva – voce (External Examiner)	5

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER VI – (CBCS New)
SKILL ENHANCEMENT MODULE

Duration – Continuous Evaluation **Max Marks-20**

Q.No.	**Criteria of Assessment**	
1	Attendance for SEM Classes and Activities	5
2	MCQ Assessment	5
3	Activity Report	5
4	Internal Viva-Voce	5

Course Material/Learning Resources

Textbooks and Reference Books

1. Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, I. D. (1999). Molecular Biology of Cell - Garland Publishing Co. Inc New York, U.S.A.
2. Bhojwani, S. S. (1990). Plant Tissue Culture: Applications and Limitations, Elsevier Science Publishers, New York. U.S.A
3. Devi, P. (2000). Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics, Agrobios, Jodhpur, India.
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5. Fakui, K. and Nakayama S. (1996). Plant Chromosomes. Laboratory Methods. CRC Press, Boca Raton, Florida.
6. Gupta P. K. (2018) Molecular Biology and Biotechnology, Rastogi Publication.
7. Gupta, P. K. (1999). A Text book of Cell and Molecular Biology, Rastogi Publication, Meerut, India.
8. Koche, D. K., Anasane, P. Y., Dagwal M.J. and Kadu, S. R. (2018). A Textbook of Botany for Sixth Semester of B. Sc. Dnyan Path Publication.
9. Kumar, S. and Singh, H. (2008) Molecular Biology and Biotechnology, Pragati Prakashan.
10. Lea, P. J. and Leegood, R. C. (1999). Plant Biochemistry and Molecular Biology. John Wiley & Sons, Chichester, England.
11. Old, R. W. and Primrose, S. B. (1989). Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, U.K.
12. Reneberge, R. and Berkling V (2017) Biotechnology for Beginers, Academic Press
13. Satyanarayana, U. and Chakrapani, U. (2022) Biotechnology, Books and Allied Publication Limited.
14. Sharma, A. K. and Sharma, A. (1999.) Plant Chromosomes: Analysis; Manipulation and Engineering. Harwood Academic Publishers, Australia.
15. Sharma, S. K. (2004) A Text Book of Biotechnology (Fundamentals of Molecular Biology)
16. Singh, B. D. (2010) Biotechnology, Kalyani Publisher
17. Smith, R. H. (2000). Plant Tissue Culture; Techniques and Experiments. Academic Press, New York.
18. Vasil, I. K. and Thorpe, T. A. (1994). Plant Cell and Tissue Culture, Kluwer Academic Publications, the Netherlands.
19. Wolfe, S. L. (1993). Molecular and Cell Biology. Wordsworth Publishing Co., California, U.S.A.

DSE II: Plant Diversity and Systematics

Code of the Course/Subject	Title of the Course/Subject	Total Number of Period
DSE II: BOT(6S)/Botany	Plant Diversity and Systematics	72

COURSE OUTCOMES:

CO1: Comprehensive Understanding of Plant Diversity

- Describe the scope, significance, and global as well as national diversity of plant groups, including major plant biomes and their ecological roles.
- Identify and explain the diversity of plant species in various ecosystems, with particular focus on endemic and endangered species and their conservation strategies.

CO2: Principles and Applications of Plant Systematics

- Explain the principles of plant systematics, taxonomy, nomenclature, and modern phylogenetic approaches.
- Discuss the historical development of plant systematics and its importance in biological classification, including molecular techniques and the role of bioinformatics.

CO3: Morphological Analysis and Comparative Studies

- Compare and contrast the morphological features of different plant groups, understanding their evolutionary adaptations.
- Analyze the vegetative and reproductive morphology of plants, including modifications and adaptations that occur across various plant groups.

CO4: Proficiency in Plant Identification Techniques

- Utilize dichotomous keys, digital tools, and field techniques to accurately identify various plant species.
- Apply principles of plant identification in practical settings, demonstrating proficiency in the use of herbarium specimens and online resources for identification purposes.

CO5: Critical Evaluation of Bioprospecting

- Critically assess the economic and ethical aspects of bioprospecting, considering both commercial potential and conservation needs.
- Evaluate methods in bioprospecting, including exploration, collection techniques, and screening for bioactive compounds, with an understanding of the historical and modern approaches.

CO6: Innovations and Entrepreneurship in Botany

- Develop innovative research proposals or entrepreneurial ideas in the field of botany, leveraging recent advances in technology and interdisciplinary approaches.
- Explore the scope and opportunities for higher education, research, entrepreneurship, and freelancing in botany, including modern research methodologies, digital resources, and successful case studies.

Detailed Curriculum

Unit	Detail Description / Content	Periods require
Unit - I:	**Introduction to Plant Diversity:** 1.1 Scope and Opportunities in Botany • Overview of career opportunities in botany • Importance of botany in various fields • Future prospects and advancements 1.2 Global Diversity of Plants • Overview of plant diversity worldwide • Major plant biomes and their characteristics • Case studies of unique plant ecosystems 1.3 National Diversity of Plants (India) • Diversity of plant species in India • Endemic and endangered plant species • Conservation strategies and policies 1.4 Plant Groups Overview • Classification of plant groups (algae, bryophytes, pteridophytes, gymnosperms, angiosperms) • Key characteristics and differences 1.5 Importance of Plant Diversity • Ecological significance • Economic and cultural importance • Role in maintaining biodiversity	12
Unit - II:	**Plant Systematics:** 2.1 Introduction to Plant Systematics • Definition and scope • Historical development of plant systematics • Importance in biological classification 2.2 Taxonomy and Nomenclature • Principles of taxonomy • Binomial nomenclature • Rules and conventions in naming plants 2.3 Phylogenetics and Cladistics • Basic concepts of phylogenetics • Cladistics and its applications • Phylogenetic trees and their interpretation 2.4 Modern Approaches in Plant Systematics • Molecular techniques (DNA barcoding, genomics) • Role of bioinformatics • Integrative taxonomy 2.5 Case Studies in Plant Systematics • Examples of plant families and genera • Evolutionary relationships and classification • Impact of systematics on conservation	12
Unit - III:	**Plant Morphology:** 3.1 Introduction to Plant Morphology • Definition and significance • Comparative morphology of major plant groups 3.2 Vegetative Morphology • Structure and function of roots, stems, and leaves • Modifications and adaptations 3.3 Reproductive Morphology • Flower structure and function • Inflorescences, fruits, and seeds • Pollination and dispersal mechanisms 3.4 Comparative Morphology • Morphological differences between plant groups • Evolutionary adaptations in morphology 3.5 Practical Applications of Morphology • Role in identification and classification • Importance in ecological studies and agriculture	12

Unit – IV:	**Identification Process and Keys** 4.1 Introduction to Plant Identification • Importance and challenges • Basic principles and techniques 4.2 Dichotomous Keys • Construction and use of dichotomous keys • Practice in identifying plants using keys 4.3 Field Identification Techniques • Tools and methods for field identification • Importance of herbarium specimens 4.4 Digital Tools for Plant Identification • Overview of digital identification tools and apps • Use of databases and online resources 4.5 Case Studies in Plant Identification • Examples of identification challenges and solutions • Role of experts and collaboration in accurate identification	12
Unit – V:	**Bioprospecting:** 5.1 Introduction to Bioprospecting • Definition and significance • Historical perspectives and modern approaches 5.2 Methods in Bioprospecting • Exploration and collection techniques • Screening and evaluation of bioactive compounds 5.3 Economic and Ethical Aspects • Commercial potential of plant-derived products • Ethical considerations and benefit-sharing 5.4 Case Studies in Bioprospecting • Success stories of plant-based discoveries • Challenges and future directions 5.5 Bioprospecting in India • Richness of Indian flora for bioprospecting • Government policies and initiatives	12
Unit – VI:	**Recent Advances in Higher Education, Research, Entrepreneurship, and Freelancing:** 6.1 Advances in Higher Education • Emerging trends in botanical education • Online learning and digital resources 6.2 Research Methodologies • Modern research techniques in botany • Interdisciplinary research approaches 6.3 Entrepreneurship in Botany • Opportunities for botanical startups • Case studies of successful botanical entrepreneurs 6.4 Freelancing in Botany • Scope and opportunities for freelancers • Building a career as a botanical consultant or writer 6.5 Future Directions and Innovations • Potential areas of research and development • Role of technology in advancing botanical sciences	12

Sant Gadge Baba Amravati University, Amravati
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Programme: B.Sc. III Semester VI

Practical Semester VI: DSE II: Plant Diversity and Systematics

Code of the Course/Subject	Title of the Course/Subject	Practicals per week
DSE II: BOT(6S)/Botany	Plant Diversity and Systematics	02 Practical per Week

1.	**Plant Diversity: Major (Any Three)** 1. Survey and Collection of Local Flora 2. Study of Plant Biomes 3. Comparative Morphology of Major Plant Groups 4. Endemic and Endangered Species Study 5. Vegetative and Reproductive Adaptations **Plant Diversity: Minor (Any Three)** 1. Diversity in Algae 2. Bryophyte Survey 3. Pteridophyte Diversity 4. Gymnosperm Identification 5. Angiosperm Floral Diversity
2.	**Plant Systematics:** **Major Experiments (Any Three)** 1. Taxonomic Classification of Plants 2. Construction and Use of Dichotomous Keys 3. Molecular Phylogenetics 4. Herbarium Techniques and Curation 5. Systematics of Specific Plant Families **Minor Experiments (Any Three)** 1. Field Identification Techniques 2. Use of Digital Identification Tools 3. Comparative Study of Plant Families 4. Application of Bioinformatics in Systematics 5. Plant Nomenclature and Taxonomic Literature

Practical Evaluation Semester VI

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER V – (CBCS New)
Practical – VI Plant Diversity and Systematics

Duration – Continuous Evaluation **Marks-25**

Internal Practical Examination

1.	Attendance/ Active participation in Lab sessions, Regularity, etc	**5**
2.	Student performance - Seminar/ Group Discussion and other formative assessment related to the subject.	**5**
3.	Activity report- Academic /Institute/Industrial/Field visit or any report activity related to the subject.	**5**
4.	Class record	**5**
5.	Viva – voce (Internal Examiner)	**5**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER V – (CBCS New)
Practical – VI Plant Diversity and Systematics

Time: 4 hrs. **Max. Marks: 25**

External Practical Examination

Q. 1 – Plant Diversity - Major experiment	7
Q. 2 – Plant Diversity - Minor experiment	3
Q. 3 – Plant Systematics - Major Experiment	7
Q. 4 – Plant Systematics - Minor Experiment	3
Q. 5 - Viva – voce (External Examiner)	5

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION (Botany), SEMESTER VI – (CBCS New)
SKILL ENHANCEMENT MODULE

Duration – Continuous Evaluation **Max Marks-20**

Q.No.	**Criteria of Assessment**	
1	Attendance for SEM Classes and Activities	5
2	MCQ Assessment	5
3	Activity Report	5
4	Internal Viva-Voce	5

Bibliography:

Reference/Text Books/Research Articles

1. Bhattacharyya, B. (2009). **Systematics of Angiosperms**. Narosa Publishing House.
2. Cronquist, A. (1981). **An Integrated System of Classification of Flowering Plants**. Columbia University Press.
3. Gifford, E. M., & Foster, A. S. (1989). **Morphology and Evolution of Vascular Plants**. W. H. Freeman and Company.
4. Gurcharan, S. (2015). **Plant Systematics: Theory and Practice**. Oxford & IBH Publishing Co. Pvt. Ltd.
5. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2008). **Plant Systematics: A Phylogenetic Approach**. Sinauer Associates.
6. Kapil, R. N., & Goyal, V. K. (1984). **Pteridophyta: Morphology, Systematics, and Evolution**. Scientific Publishers.
7. Kumar, N. (2013). **Plant Diversity in India**. Dehradun Publishing House.
8. Maheshwari, P. (1950). **An Introduction to the Embryology of Angiosperms**. McGraw-Hill Book Company, Inc.
9. Singh, G. (2016). **Plant Systematics: An Integrated Approach**. CRC Press.
10. Singh, V., & Jain, D. K. (2003). **Taxonomy of Angiosperms**. Rastogi Publications.

E Contents, E-Books (Free Available or Purchase Links)

1. Angiosperm Phylogeny Group. (2016). **APG IV classification for the orders and families of flowering plants**. *Botanical Journal of the Linnean Society, 181*(1), 1-20. Retrieved from https://academic.oup.com/botlinnean/article/181/1/1/2416499
2. Beentje, H. (2016). **The Kew Plant Glossary: An Illustrated Dictionary of Plant Terms**. Kew Publishing. Purchase link: https://shop.kew.org/the-kew-plant-glossary
3. Hickey, M., & King, C. (2000). **The Cambridge Illustrated Glossary of Botanical Terms**. Cambridge University Press. Purchase link: https://www.cambridge.org/core/books/cambridge-illustrated-glossary-of-botanical-terms/0A8D09A2D504E1C57D63D759D84CE77E
4. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2008). **Plant Systematics: A Phylogenetic Approach** (3rd ed.). Sinauer Associates. Purchase link: https://www.sinauer.com/plant-systematics-a-phylogenetic-approach-785.html
5. Simpson, M. G. (2010). **Plant Systematics** (2nd ed.). Elsevier Academic Press. Purchase link: https://www.elsevier.com/books/plant-systematics/simpson/978-0-12-374380-0

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1. Botanical Survey of India. (n.d.). Retrieved from http://bsi.gov.in/
2. eFlora of India. (n.d.). Retrieved from https://www.efloras.org/flora_page.aspx?flora_id=5
3. India Biodiversity Portal. (n.d.). Retrieved from https://indiabiodiversity.org/
4. Kew Science. (n.d.). **Plants of the World Online**. Retrieved from http://powo.science.kew.org/
5. The Plant List. (2013). **A working list of all plant species**. Retrieved from http://www.theplantlist.org/

Educational Software, Databases, etc.

1. Bioinformatics.org. (n.d.). **Clustal Omega**. Retrieved from http://www.clustal.org/omega/
2. ExPASy Bioinformatics Resource Portal. (n.d.). **Translate tool**. Retrieved from https://web.expasy.org/translate/
3. MEGA (Molecular Evolutionary Genetics Analysis). (n.d.). Retrieved from https://www.megasoftware.net/
4. NCBI. (n.d.). **GenBank**. Retrieved from https://www.ncbi.nlm.nih.gov/genbank/
5. PlantNet. (n.d.). **Plant identification application**. Retrieved from https://identify.plantnet.org/

Skill Enhancement Module (SEM) Semester VI

Any One of the Following (Teaching Hours: 12 and Practical Sessions:03; Marks: 20)

1. Bioinformatics Tools and Techniques

Unit	Detail Description / Content
	CO's: 1. The students will learn the fundamental concept of bioinformatics and its scope and applications 2. They will explore various nucleic acid and protein databases and learn sequence alignment 3. They will acquire knowledge about sequence alignment tools and create phylogenetic tree using various related tools.
Unit - I:	**Bioinformatics Tools and Techniques** 1.1 Introduction to Bioinformatics and its scope 1.2 Exploring databases like NCBI and PDB 1.3 Sequence alignment tools like BLAST, FASTA, ClustalW 1.4 Tools for Phylogenetic analysis like PAUP and MrBayes 1.5 Applications of Bioinformatics
	Activities: 1 Retrieval of DNA/RNA/protein sequences from databases 2 Exploring the integrated database system at NCBI server and querying the PUBMED and GenBank databases using the ENTREZ search engine 3 Sequence alignment: database searches (BLAST, FASTA etc.) 4 Phylogenetic tree construction using prescribed tools.

2. Cell Culture Technique:

Unit	Detail Description / Content
	CO's: Upon successful completion of this module, students will be able to: 1. Describe the significance and broad applications of cell culture in research, medicine, and industry. 2. Differentiate between various types of cell cultures, including primary cells and cell lines. 3. Understand the principles behind aseptic techniques, the importance of sterility, and the design and functionality of specialized equipment used in cell culture. 4. Demonstrate proficiency in aseptic techniques, Isolation, culture, and maintain primary cells and cell lines, ensuring their health and viability. 5. Diagnose common cell culture problems, including contamination, and apply appropriate measures to prevent or address these issues. 6. Integrate knowledge and skills from cell culture techniques with other related disciplines such as molecular biology, genetics, and biotechnology.
Unit - I:	1.1. Cells with Culture Potential: Different types of cell cultures: primary vs. cell lines 1.2. Cell Isolation methods: Tissue disaggregation and enzymatic digestion 1.3. Media, Serum, and Additives: Components and types of culture media; Additives like antibiotics, growth factors, and other supplements 1.4. Initial seeding, Growth conditions, monitoring growth and calculating growth curves 1.5. Challenges, Ethical and Special considerations 1.6. Applications in research, medicine, and industry
	Activities: 1. **Hands-on Workshops:** Basic cell culture techniques: media preparation, seeding cells, passaging, etc. 2. **Problem-solving Sessions:** Present students with real-world cell culture challenges (e.g., contamination issues, unexpected cell behavior) and guide them in troubleshooting.

	3. Team-based Experiments: Divide students into teams and assign specific roles (e.g., media preparer, cell counter, data analyst) to foster teamwork and collaboration. **4. Field Activities:** **Visits:** Organize visits to advanced cell culture facilities, research labs, or biotech companies to expose students to real-world applications and industry standards. **Guest Lectures:** Invite professionals or researchers in the field of cell culture to share their expertise, experiences, and insights.

3. DNA Extraction, Quantification, and Purity Assessment

Unit	Detail Description / Content
	CO's: **Upon successful completion of this module, students will be able to:** 1. Identify various sources of DNA and the importance of sample preparation and storage for optimal DNA yield and quality. 2. Execute DNA extraction from diverse samples using various methods, including chemical, solid-phase, and enzymatic techniques. 3. Quantify DNA concentrations employing both absorbance-based and fluorescence-based techniques with accuracy. 4. Evaluate DNA quality and integrity through gel electrophoresis and interpret the resulting patterns. 5. Diagnose and address common challenges encountered during DNA extraction, quantification, and purity assessment, ensuring optimal yield and quality. 6. Apply best practices for specific sample types to overcome inherent challenges in DNA extraction and purification. 7. Integrate knowledge of DNA extraction, quantification, and assessment for downstream molecular biology applications such as PCR, sequencing, and cloning.
Unit - I:	**1.1 DNA Sources and Sample Preparation:** Bacterial cells, plant tissues, animal cells, blood, and environmental samples; Sample storage and preparation considerations; Importance of aseptic technique and sample integrity **1.2 DNA Extraction Methods:** Chemical extraction methods: Liquid Nitrogen, CTAB, Phenol-chloroform extraction, etc.; Solid-phase extraction: Silica/glass fiber-based column extraction; Enzymatic methods: using lysozyme, protease, etc.; Commercial kits and their applications **1.3 DNA Quantification:** UV spectrophotometry, Gel electrophoresis and ethidium bromide staining **1.4 Common Challenges and Troubleshooting:** Addressing low yield or poor-quality DNA, Overcoming challenges with specific sample types, Dealing with contaminants: proteins, polysaccharides, and solvents **1.5 Storage and Archival of Extracted DNA:** Proper storage conditions for short-term and long-term, DNA degradation: causes and prevention
	Activities: **1. Hands-on Workshops (Any one):** a) DNA extraction from various sources using different methods. b) DNA quantification using UV spectrophotometry and fluorescence methods. c) Evaluating DNA purity with UV absorbance ratios. d) Analyzing DNA quality and integrity through agarose gel electrophoresis. 2. **Problem-solving Sessions:** Troubleshooting exercises where students diagnose problems with DNA extraction, quantification, or quality. 3. **Group or individual presentations**: Simulations on the topics or case studies related to DNA extraction and assessment. **4. Field Activities:** **Visits:** Organize visits to Labs having routine practice of DNA Isolation, purification, evaluation viz. Forensic Lab, PCR Labs, etc. **Guest Lectures:** Invite professionals or researchers in this field to share their expertise, experiences, and insights.

4. Seed Development Technology

Unit	Detail Description / Content
	CO's: **Upon successful completion of this module, students will be able to:** 1. To recall and describe the fundamental processes of seed biology, including seed formation, structure, and function. 2. To demonstrate understanding of the basic principles of seed technology, including seed treatment, enhancement techniques, and genetic modifications. 3. To apply techniques of seed treatment, sorting, grading, and testing in a practical laboratory setting. 4. To analyze germination test results and other seed quality control measures to assess seed viability and vigor. 5. To integrate knowledge of seed biology and technology to design a seed treatment plan for a specific agricultural application, considering factors such as crop type, environmental conditions, and desired traits. 6. To critically evaluate recent advances and ethical considerations in seed technology, formulating well-reasoned opinions on the impact of these technologies on agriculture and society.
Unit - I:	**1.1 Introduction to Seed Biology:** A. Introduction to plant biology and seed formation; B. Seed structure and function; C. The role of seeds in agriculture and biotechnology. **1.2 Seed Technology and Production:** A. Techniques in seed technology—seed enhancement, priming, and pelleting. B. Seed production processes and certification. C. Genetic engineering in seed development. **1.3 Seed Storage and Quality Control:** A. Principles of seed storage, viability, and vigor. B. Seed testing for quality control—purity tests, germination tests, etc. C. Regulations and ethical considerations in seed technology. **1.4 Innovative Approaches in Seed Technology:** A. Recent advances in seed technology (CRISPR, Gene editing). B. The role of biostimulants and nanotechnology in seed enhancement. C. Case studies on successful seed technology applications.
	Activities: 1. Microscopic examination of different seed structures. 2. Discussion on the implications of seed structure for development and growth. 3. Demonstration of seed treatment methods (e.g., priming, coating). 4. Practical exercise on seed sorting and grading techniques. 5. Case study analysis and group presentation. 6. Discussion on potential future innovations in seed development.

5. Botanical Excursion Management

Unit	Detail Description / Content
	CO's: **Upon successful completion of this module, students will be able to:** 1. Understand the fundamentals of botanical excursion management. 2. Develop skills in planning and organizing botanical excursions. 3. Learn to identify and document various plant species. 4. Acquire knowledge of safety and environmental regulations during excursions. 5. Enhance leadership and teamwork capabilities in field settings. 6. Apply techniques for effective communication and interpretation of botanical information.

Unit - I:	**Introduction to Botanical Excursion Management** ***1.1 Overview of Botanical Excursions*** • **Definition and Purpose**: Understanding what botanical excursions are and why they are important for education, research, and conservation. • **Types of Excursions**: Various forms of botanical excursions such as educational trips, research expeditions, and conservation missions. • **Historical Perspective**: A brief history of botanical excursions and their evolution over time. • **Key Objectives**: Primary goals of conducting botanical excursions, including plant identification, ecological studies, and public engagement. ***1.2 Planning and Preparation*** • **Pre-Excursion Research**: Conducting background research on the destination, local flora, and potential study areas. • **Itinerary Development**: Crafting a detailed schedule including timelines, locations, activities, and objectives for each day. • **Resource Allocation**: Identifying and securing necessary resources such as transportation, accommodation, food, and field equipment. • **Permissions and Permits**: Understanding the legal requirements and obtaining necessary permissions from local authorities and landowners. ***1.3 Tools and Equipment*** • **Field Equipment**: Essential tools for botanical excursions such as GPS devices, field guides, plant presses, notebooks, and cameras. • **Data Collection Tools**: Methods and devices for collecting data including quadrats, transects, and sampling kits. • **Safety Gear**: Items such as first aid kits, protective clothing, and emergency communication devices. • **Technology in the Field**: Utilization of apps and software for plant identification, data recording, and analysis. ***1.4 Safety and Environmental Considerations*** • **Risk Assessment**: Identifying potential hazards and risks associated with botanical excursions and developing mitigation strategies. • **First Aid and Emergency Procedures**: Basic first aid knowledge and emergency response plans tailored to fieldwork scenarios. • **Environmental Ethics**: Principles of minimizing environmental impact, including Leave No Trace guidelines and sustainable practices. • **Regulations and Compliance**: Understanding and adhering to environmental laws, protected area regulations, and ethical guidelines for research and conservation activities. ***1.5 Plant Identification*** • **Identification Techniques**: Methods for identifying plants using morphological characteristics, such as leaf shape, flower structure, and bark texture. • **Field Guides and Apps**: Utilizing field guides and mobile applications for accurate plant identification. • **Notable Species**: Highlighting important, interesting, and unique plant species that participants might encounter during excursions. • **Documentation and Records**: Recording plant species data effectively, including notes, sketches, and photographs. ***1.6 Documentation and References*** • **Documentation Techniques**: Effective methods for documenting observations and findings during excursions.

	• **Reference Creation**: Developing comprehensive reference materials for various destinations to aid future users. • **Multi-User Access**: Ensuring documentation is accessible and useful for multiple users through digital platforms or physical guides. • **Example References**: Showcasing well-documented excursions and their contributions to botanical knowledge and conservation efforts.
	Activities: 1. **Field Trip Planning:** Develop a detailed plan for a botanical excursion including itinerary, objectives, and resources. 2. **Species Identification:** Practice identifying and documenting local plant species using field guides and apps. 3. **Safety Drill:** Conduct a mock safety drill to prepare for potential hazards during excursions. 4. **Team Building Exercise:** Participate in team-building activities to foster effective collaboration among participants. 5. **Presentation:** Create and deliver a presentation on a specific plant species or botanical area, highlighting its ecological importance and conservation status.

6. Exploring Phytochemical Wealth: Bioprospecting Plant Materials

Unit	Detail Description / Content
	CO's: **Upon successful completion of this module, students will be able to:** 1. Understand the principles and significance of bioprospecting and phytochemical investigations. 2. Develop skills in identifying and selecting plant materials for phytochemical studies. 3. Learn various types of phytochemical investigations and their applications. 4. Acquire knowledge of methodologies for conducting proximate analysis tests. 5. Gain expertise in qualitative and quantitative analysis of plant samples. 6. Evaluate the cost and benefits of bioprospecting and phytochemical research.
Unit - I:	**Fundamentals of Bioprospecting and Phytochemical Investigations** ***1.1 Review of Literature*** • **Significance and History**: Importance of bioprospecting in drug discovery and natural product research. • **Literature Search Techniques**: Methods for conducting comprehensive literature reviews, including database searches and evaluating sources. • **Case Studies**: Examination of notable bioprospecting success stories and their impact on medicine and industry. • **Current Trends**: Recent advancements and trends in bioprospecting and phytochemical research. ***1.2 Plant Identification*** • **Selection Criteria**: Criteria for selecting plants for phytochemical studies, including ethnobotanical relevance and biodiversity hotspots. • **Identification Techniques**: Methods for accurate identification of plants, including morphological characteristics and molecular tools. • **Documentation and Herbarium**: Importance of proper documentation and creating herbarium specimens for reference. • **Notable Species**: Highlighting important plant species known for their phytochemical properties.

	1.3 Types of Phytochemical Investigations • **Primary Metabolites**: Investigation of essential metabolites such as carbohydrates, proteins, and lipids. • **Secondary Metabolites**: Study of secondary metabolites including alkaloids, flavonoids, terpenoids, and phenolics. • **Extraction Methods**: Techniques for extracting phytochemicals from plant materials, such as solvent extraction and distillation. • **Analytical Techniques**: Methods for analyzing phytochemicals, including chromatography, spectroscopy, and mass spectrometry. ***1.4 Methodologies for Proximate Analysis*** • **Moisture Content**: Determination of moisture content using techniques like oven drying and Karl Fischer titration. • **Ash Content**: Measurement of total ash content to assess mineral composition. • **Fiber Analysis**: Techniques for analyzing crude fiber and dietary fiber content. • **Protein and Lipid Analysis**: Methods for determining protein and lipid content, such as Kjeldahl method and Soxhlet extraction. ***1.5 Comprehensive Phytochemical Analysis*** • **Qualitative Analysis**: Techniques for identifying the presence of various phytochemicals in plant samples. • **Quantitative Analysis**: Methods for quantifying the concentration of phytochemicals, including HPLC and GC-MS. • **Bioactivity Testing**: Assessing the biological activity of phytochemicals through in vitro and in vivo tests. • **Data Interpretation**: Interpreting the results of phytochemical analyses to understand the chemical profile and potential applications of plant samples.
	Activities: 1. **Literature Review Project**: Conduct a detailed literature review on a selected plant species, including history, known phytochemicals, and potential applications. 2. **Phytochemical Extraction and Analysis**: Perform extraction and preliminary analysis of phytochemicals from collected plant samples. 3. **Proximate Analysis Laboratory Session**: Conduct proximate analysis tests on plant samples to determine moisture, ash, fiber, protein, and lipid content. 4. **Cost-Benefit Analysis Exercise**: Calculate the costs and potential benefits of bioprospecting a particular plant species, considering market value and potential applications. 5. **Market Research Project**: Conduct market research to identify potential commercial applications and financial gain from identified phytochemicals. 6. **Bioactivity Testing Workshop**: Participate in a workshop to learn about and conduct bioactivity testing on extracted phytochemicals. 7. **Simulation Exercise**: Simulate the entire process of bioprospecting, from plant selection to market analysis, to understand the workflow and economic implications.

Sant Gadge Baba Amravati University, Amravati
Syllabus Prescribed for Three-Year UG Programme
Programme: B.Sc. III
Semester VI (CBCS Scheme)

General Interest Course (GIC) for Semester VI

Code of the Course/Subject	Title of the Course/Subject	Total Number of Period
BOT(6S)/Botany (GIC)	AI in Plant Sciences	30

Course Outcomes:

CO1: Knowledge – Recall and describe the basic concepts and technologies of artificial intelligence as they apply to botanical studies.
CO2: Comprehension – Explain the significance and potential impacts of integrating AI into botanical research and applications.
CO3: Application – Apply AI and ICT tools in the identification and visualization of botanical specimens.
CO4: Analysis – Analyze data using AI techniques to derive meaningful insights in botanical studies.
CO5: Synthesis – Integrate various AI tools and techniques to innovate or improve experimental methods in botany.
CO6: Evaluation – Critically evaluate the effectiveness, ethics, and sustainability of AI applications in botanical sciences.

Curriculum

Unit	Detail Description / Content	Periods require
Unit - I:	**Integration of Artificial Intelligence in Botany:** 1.6 **Introduction to Artificial Intelligence:** Definition, distinction between General AI and Super AI. 1.7 **Evolution and Impact of AI:** Historical development, foundations, societal influences, application domains, associated technologies, and future prospects. 1.8 **AI Techniques and Processes:** Introduction to Machine Learning, Deep Learning, Natural Language Processing, and Robotics with examples of their application in solving real-world problems. 1.9 **Challenges and Ethical Considerations in AI:** Exploration of the major challenges in AI development and deployment, including ethical considerations.	15
Unit - II:	**Applications of AI and ICT in Botanical Studies:** 2.6 **ICT Tools in Botany:** Use of AI and MATLAB software for the study of Cryptogams; introduction to image processing techniques. 2.7 **Advanced Visualization Techniques:** Application of AI and image processing in cell visualization and lichen identification. 2.8 **AI in Biological Integration and Discovery:** How AI helps in biological knowledge discovery, behavioral ecology, from genes to phenotypes. 2.9 **Predictive Biology and Disease Control:** Use of AI to predict evolution, control infectious diseases, and in conservation biology.	15

Course Material/Learning Resources

Textbooks and Reference Books

1. Balasubramaniam, R., & Murty, M. N. (2013). Machine Learning Algorithms. Universities Press.
2. Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer.
3. Bostock, M., Ogievetsky, V., & Heer, J. (2011). D3 - Data-Driven Documents. IEEE Transactions on Visualization and Computer Graphics. (This reference includes concepts that could be applied in visualization of botanical data.)
4. Chollet, F. (2018). Deep Learning with Python. Manning Publications.
5. Ghosh, J., & De, R. K. (2008). Bioinformatics: Principles and Applications. Oxford University Press.
6. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
7. Hastie, T., Tibshirani, R., & Friedman, J. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd ed.). Springer.
8. Jetz, W., McPherson, J. M., & Guralnick, R. P. (2012). Integrating biodiversity distribution knowledge: Toward a global map of life. Trends in Ecology & Evolution, 27(3), 151-159.
9. Kelleher, J. D., & Tierney, B. (2018). Data Science. MIT Press. (Includes fundamentals of data handling that can be crucial for managing botanical datasets.)
10. Krishna, B. G. (2014). Plant Biology and Biotechnology. Springer India.
11. Murphy, K. P. (2012). Machine Learning: A Probabilistic Perspective. MIT Press.
12. Parnell, J., & Jackson, P. (2013). Plant Ecology. Wiley-Blackwell.
13. Rajaraman, V. (2017). Artificial Intelligence. PHI Learning Private Limited.
14. Reddy, V. U., & Murty, M. N. (2019). Deep Learning for Biometrics. Springer.
15. Russell, S. J., & Norvig, P. (2016). Artificial Intelligence: A Modern Approach (4th ed.). Pearson Education.
16. Silver, D., Huang, A., Maddison, C. J., Guez, A., Sifre, L., van den Driessche, G., Schrittwieser, J., Antonoglou, I., Panneershelvam, V., Lanctot, M., Dieleman, S., Grewe, D., Nham, J., Kalchbrenner, N., Sutskever, I., Lillicrap, T., Leach, M., Kavukcuoglu, K., Graepel, T., & Hassabis, D. (2016). Mastering the game of Go with deep neural networks and tree search. Nature, 529(7587), 484-489.

Websites

17. TensorFlow. (n.d.). https://www.tensorflow.org/
18. NatureServe. (n.d.). https://www.natureserve.org/
19. AI in Conservation. (n.d.). http://aiinconservation.org/
20. Types of Artificial Intelligence. https://www.edureka.co/blog/types-of-artificial-intelligence/
21. What is Artificial Intelligence? https://www.mygreatlearning.com/blog/what-is-artificialintelligence/#WhatisArtificialIntelligence

Pedagogy

E-content, Lecture, Power point presentation, Seminar, Assignment, Quiz, Group Discussion, Video / Animation