DEPARTMENT OF BOTANY

SYLLABI AND SCHEME OF EXAMINATIONS FOR DISCIPLINE SPECIFIC COURSES

Bachelor of Science (Life Sciences) Program under NEP-2020

Under multiple entry, exit, internship and Learning Outcomes Based Curriculum and Credit Framework for Bachelor of Science (Botany as Single Major) Program

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

DEPARTMENT OF BOTANY

Name of the Program: B.Sc. (Life Sciences) with Hons. in Botany

Duration of the Program: Three/Four Years

Total Credits for the Program: 180

Program Specific outcomes

PSO1: Develop core competency for identification of plant groups (Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms).

PSO2: Understand the classification and conservations of plants for enriching the plant diversity

PSO3: Skill development for challenging area of ecology and reproductive biology

PSO4: Fuse traditional components with modern aspects of plant biology

PSO5: Use the modern tools and techniques in botanical research

PSO6: Develop analytical and problem solving skills for getting significance results

Credit matrix for Ist Year of B.Sc. (Life Sciences) program with Hons. in Botany

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary courses (MDC)	Ability Enhancement courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
I	12	4	3	2	3	2	26
II	12	--	3	2	3	2	22

*Students exiting the programme after second semester and securing 52 credits including 4 credits of summer internship (*24BOTS402IN1*) will be awarded UG Certificate in the relevant Discipline/ Subject*

Credit matrix for 2nd Year of B.Sc. (Life Sciences) program with Hons. in Botany

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary courses (MDC)	Ability Enhancement courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
III	12	4	3	2	3	--	24
IV	12	4	--	2	--	2	20

*Students exiting the programme after fourth semester and securing 96 credits including 4 credits of summer internship (*25BOTS404IN1*) will be awarded UG Diploma in the relevant Discipline/Subject.*

Credit matrix for 3rd Year of B.Sc. (Life Sciences) program with Hons. in Botany

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary courses (MDC)	Ability Enhancement courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
V	12	4	-	--	4 (internship)	--	20
VI	12	8	-	--	--	--	20

Students will be awarded 3-year UG Degree in the relevant Discipline/Subject upon securing 132 credits.

Credit matrix for 4th Year of B.Sc. (Life Sciences) with Hons. in Botany (Option 1*- Only course work)

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary courses (MDC)	Ability Enhancement courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
VII	20	4	-	--	--	--	24
VIII	20	4	-	--	--	--	24

Credit matrix for 4th Yr of B.Sc. (Life Sciences) with Hons. in Botany (Option 2* course work with Research)

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary courses (MDC)	Ability Enhancement courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
VII	20	4	-	--	--	--	24
VIII	08	4	-	--	12 (RP/ Dissertation)	--	24

Total Credits for 4yr UG (Hons with Research) program are 180

*****Student should select one major discipline (Out of Botany, Zoology, or Chemistry studied during first three years of UG Programmes) in which he/she wishes to pursue Honors.*

Note: *This framework is subject to modification as per UGC guidelines at the University level. The universities may decide to offer the Honors degree Programmes subject to the fulfilment of credit point table*

- Students entering 4th year Graduate Program after a 3-year UG program can choose to do:

i) Only course work in the 7th and 8th semester **(Option -1) OR**
ii) Course work in the 7th and research in the 8th semester **(Option -2)**

- Skill Enhancement courses for imparting skills related to major/minor

Internship:

- Four credits of internship earned by a student during summer internship after 2nd *(*25BOTS403IN1*)* semester or 4th *(*26BOTS405IN1*)* semester will be counted in 5th semester of a student who pursue 3 year UG Programmes without taking exit option.

Internship Evaluation

After completion of internship, students need to prepare a comprehensive report highlighting their learning and takeaways during the internship period as per ***MDUR Internship Regulations 2025****. The report shall be signed by the Internship Supervisor from respective UTD/Centre/College and Mentor from internship providing organizations. Evaluation of internship report and viva-voce will be jointly conducted by Internship Supervisor and Mentor on the time and date notified by the concerned HoDs/Directors/Principals. The mentor from host organization may participate in the evaluation through online/offline mode. In case of non-availability of respective mentor, the available relevant mentor as decided by the concerned HOD/Director/Principal may be utilized for the purpose of evaluation.*

Suggested distribution of marks will be as below:

<table>
<tr><th>S. No.</th><th>Components</th><th>Employability-Oriented Internship</th><th>Research-Oriented Internship</th></tr>
<tr><td>1</td><td>Assessment by Mentor
<table>
<tr><td>S.No.</td><td>Details</td><td>Marks</td></tr>
<tr><td>1</td><td>Skills learned</td><td>15</td></tr>
<tr><td>2</td><td>Regularity</td><td>10</td></tr>
<tr><td>3</td><td>Conduct</td><td>5</td></tr>
<tr><td></td><td>Total (30)</td><td></td></tr>
</table></td><td>30</td><td>30</td></tr>
<tr><td>2</td><td>Internship Report</td><td>40</td><td>40</td></tr>
<tr><td>3</td><td>Viva-Voce</td><td>30</td><td>30</td></tr>
</table>

INSTRUCTIONS FOR THE STUDENTS

Course Types

Discipline Specific Course (DSC)/Major Course
Discipline specific/Major course is the discipline or subject of main focus in which the degree will be awarded. Students should secure the prescribed number of credits (at least 50% of total credits) through Discipline Specific Course/Major Course in the major discipline.

Minor Course (MIC)

Minor discipline is the discipline that helps a student to gain a broader understanding beyond the major discipline. For example, if a student pursuing Economics as major course may choose Statistics as minor course.

Vocational Course (VOC)
Vocational Course assists student in developing workforce-relevant skills and enhance the employability of student.

Multidisciplinary Course (MDC)
A Multidisciplinary Course is an option to explore disciplines of interest beyond the choices of learners made in their major and minor disciplines.

Ability Enhancement Course (AEC)
Ability Enhancement Course aims to achieve competency in language and communication skills
.

Skill Enhancement Course (SEC)
Skill Enhancement Course aims to promote skills pertaining to a particular field of study, impart practical skills, hands-on training, soft skills, etc., in order to enhance the student's employability.

Internship
Internship is a course to develop a professional ability through an appropriate learning. The duration of Internship is of 120 hours during summer vacation.

Research Project
Research Project is a course involving applications of knowledge in exploring, analyzing and solving real-life situations/problems.

Dissertation
Dissertation is a long piece of academic writing based on original research.

Value Added Course (VAC)
Value Added Course aims to add the knowledge of learner beyond academic disciplines.

Semester/Academic Year
A semester comprises 90 working days and an academic year is divided into two semesters.

Academic Bank Account
Academic Bank Account is an individual account with the Academic Bank of Credits opened and operated by a student, to which all academic credits earned by the Student from course(s) of study are deposited, recognized, maintained, accumulated, transferred, validated or redeemed for the purposes of the award of degree/diploma/certificates etc. by an awarding institution.

Multiple Entry and Exit Points
These are stages where the students may have options for entry and exit as per UGC Guidelines for Multiple Entry and Exit in Academic Programs.

Credit Point: It is the product of the grade point and the number of credits for a course.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.

Semester Grade Point Average (SGPA): The SGPA is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

Cumulative Grade Point Average (CGPA): The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal place.

SCHEME OF EXAMINATIONS FOR DISCIPLINE SPECIFIC COURSES FOR B. Sc. (Life Sciences) PROGRAM WITH HONS. IN BOTANY

Discipline Specific Courses/ Major Course	Nomenclature of Course	Course Code	Credits Distribution			Total Credits	Workload			Total Workload	Marks			Total Marks
			L	T	P		L	T	P		Theory		Practical	
											Internal	External		
Semester I														
DSC @ 4 credits	Diversity of Microbes	24BOTM401DS01	2	0	2	04	2	0	4	06	15	35	50	100
Semester II														
DSC @ 4 credits	Diversity of Archegoniate	24BOTM402DS01	2	0	2	04	2	0	4	06	15	35	50	100
Semester III														
DSC @ 4 credits	Plant Taxonomy	25BOTM403DS01	2	0	2	04	2	0	4	06	15	35	50	100
Semester IV														
DSC @ 4 credits	Plant Anatomy & Reproductive Biology	25BOTM404DS01	2	0	2	04	2	0	4	06	15	35	50	100
Semester V														
DSC @ 4 credits	Plant Physiology	26BOTM405DS01	2	0	2	04	2	0	4	06	15	35	50	100
Semester VI														
DSC @ 4 credits	Plant Biochemistry & Metabolism	26BOTM406DS01	2	0	2	04	2	0	4	06	15	35	50	100
Semester VII 4 year UG with Botany Hons. Program														
DSC – H1 @ 4 credits	Microbial Diversity	24BOT201DS01	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H2 @ 4 credits	Advances in Cryptogrammic Botany	24BOT201DS02	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H3	Plant Cell & Molecular	24BOT201DS003	2	0	0	04	2	0	0	06	15	35	50	100

@ 4 credits	Biology													
DSC – H4 @ 4 credits	Anatomy of Angiosperms	24BOT201DS04	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H5 @ 4 credits	Plant Tissue Culture & Resource Utilization	24BOT201DS05	2	0	0	04	2	0	0	06	15	35	50	100
Students should select any one option (either I or II) for SEM –VIII of UG programme														
Semester VIII **4 year UG Botany Hons. Option 1 (only Course Work)-Option I**														
DSC – H6 @ 4 credits	Plant Biochemistry & Metabolism	24BOT202DS01	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H7 @ 4 credits	Taxonomy of Angiosperms	24BOT202DS02	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H8 @ 4 credits	Plant Biotechnology	24BOT202DS03	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H9 @ 4 credits	Evolutionary and Economic Botany	24BOT202DS04	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H10 @ 4 credits	Techniques in Plant Sciences	24BOT202DS05	2	0	0	04	2	0	0	06	15	35	50	100
Semester VIII **4 year UG Botany Hons. Option 1 (Course Work with Research)- Option II**														
DSC – H6 @ 4 credits	Plant Biochemistry & Metabolism	24BOT202DS01	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H7 @ 4 credits	Taxonomy of Angiosperms	24BOT202DS02	2	0	0	04	2	0	0	06	15	35	50	100
DSC – H8 @ 4 credits	Research Project/ Dissertation	24BOT202PD01	0	0	12	12	0	0	24	24				300

L: Lecture; T: Tutorial; P: Practical

Note: The Syllabi and Scheme of Examinations (SOE) for Discipline Specific Courses/Major Courses for UG Semester 7 and Semester 8 will be same as applicable for Syllabi and Scheme of Examinations (SOE) for Post Graduate program of semester 1 and semester 2, respectively.

SYLLABI FOR DISCIPLINE SPECIFIC COURSES FOR B.Sc. (Life Sciences) OFFERED BY DEPT. OF BOTANY

Semester: 1

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Theory)**	**Nomenclature**	**Diversity of Microbes**
Name of the Course	**Discipline Specific Course (DSC A1)**	**Course Code**	**24BOTM401DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal marks**	**15**
Time of Examination	**03 hrs.**	**External marks**	**35**

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Objectives:
To understand the diversified habitats, life cycles and economic importance of microbes (bacteria, algae and fungi) and plant groups and also to train the students for collection and preservation of microbes, algae and fungi.

Course Learning Outcomes (CLO): After completion of this course, the students will be able to acquaint themselves with the following concepts of Botany:

CLO1 General characters, ultrastructure, reproduction and economic importance of viruses and bacteria

CLO2 General characters and life-cycle of cyanobacteria and algae.

CLO3 Identification, classification, reproduction and economic importance of various fungi and Lichens.

CLO4 General concepts regarding algal blooms, mycorrhiza, homothallism and heterothallism, heterokaryosis; parasexuality; alternation of generations

Unit 1

Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV).

Bacteria: Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and

recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Unit 2

Cyanobacteria: General characters; thallus organization; cell structure; heterocyst and akinete development; reproduction; Life-cycle of *Nostoc.* Economic Importance of Cyanobacteria.

Algae: General characteristics; Algae in diversified habitats (terrestrial, freshwater, marine); thallus organization; cell ultrastructure; reproduction (vegetative, asexual and sexual); Algal classification criteria- pigments, reserve food and flagella; Classification upto classes (Smith, 1955); algal blooms and red tides; algal biofertilizers.

Unit 3

Morphology and life-cycle of *Volvox*, *Oedogonium* (Chlorophyceae), *Vaucheria* (Xanthophyceae), *Ectocarpus* (Phaeophyceae) and *Polysiphonia* (Rhodophyceae)

Economic importance of algae

Unit 4

Fungi: General characteristics; organization of thallus; nutrition and reproduction; Classification upto classes (Ainsworth, 1966); Morphology and life-cycles of *Phytophthora* (Mastigomycotina), *Mucor* (Zygomycotina), *Penicillium* (Ascomycotina), *Puccinia*, *Agaricus* (Basidiomycotina), *Colletotrichum* (Deuteromycotina); Economic importance of fungi

Lichens: Classification, morphology, internal structure, reproduction and Economic importance

Mycorrhiza: Ectomycorrhiza and endomycorrhiza and their significance

Semester: 1

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Practical)**	**Nomenclature**	**Diversity of Microbes**
Name of the Course	**Discipline Specific Course (DSC A1)**	**Course Code**	**24BOT401DS01**
Hours per Week	**04**	**Maximum Marks**	**50**
Credits	**02**	**Internal Assessment**	**15**
Duration of Examination	**03 hrs.**	**Internal Exam**	**35**

Note: Students should draw figures or diagrams and write related descriptions/ notes in their practical note books.

Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and/ or specimens related to Algae, Fungi, and lichens.

Course Objectives:
To understand the diversified habitats, life cycles and economic importance of microbes (bacteria, algae and fungi) and plant groups and also to train the students for collection and preservation of microbes, algae and fungi.

Course Learning Outcomes (CLO): After completion of this course, the students will be able to acquaint themselves with the following concepts of Botany:

CLO1 General characters, ultrastructure, reproduction and economic importance of viruses and bacteria

CLO2 General characters and life-cycle of cyanobacteria and algae.

CLO3 Identification, classification, reproduction and economic importance of various fungi and Lichens.

CLO4 General concepts regarding algal blooms, mycorrhiza, homothallism and heterothallism, heterokaryosis; parasexuality; alternation of generations

List of Practical:

1. Electron Micrographs/Models of viruses – T-Phage and TMV, Photograph/ Line drawing of lytic and lysogenic Cycle.
2. Types of bacteria from permanent slides/photographs.
3. Gram Staining and serial dilution technique of bacterial culture.
4. Study of *Rhizobium* bacteria in root nodules of leguminous plants.
5. Study of vegetative and reproductive structures of *Nostoc, Oscillatoria, Volvox, Oedogonium, Vaucheria, Ectocarpus* and *Polysiphonia* through temporary preparations and permanent slides.
6. Study of vegetative and reproductive structures of *Phytoththora, Mucor, Penicillium, Puccinia and Agaricus* through temporary mounts/ specimens / permanent slides.
7. Study of growth forms of lichens (crustose, foliose and fruticose).
8. Study of common viral, bacterial and fungal diseases of plants.
9. Study of aeromycoflora by culture plate technique.
10. Isolation of various fungal strains from soil samples.
11. Study of local algal flora through excursions and field trips.

Pattern of Practical Examination:

1. Identify, classify and write short morphological notes by drawing a well labelled relevant diagrams on the given two specimens A, B & C. (9)
2. Preparation of media (PDA, YPSS Agar media for aeroflora/ Gram Staining technique. (4)
3. Identify giving two important characters of identification of the given spots 1, 2, 3 (one

slide/ material from bacteria, fungi, lichen).	(6)
4. To identify and comment upon the given plant diseases (any 2).	(4)
5. Field visit and collection records	(4)
6. Practical records	(4)
7. Viva-voce	(4)

References/Suggested readings:

- Smith, G.M. 1971. Cryptogamic Botany. Vol. I. Algae & Fungi. Tata McGraw Hill Publishing Co., New Delhi.
- Sharma, P.D. 1991. The Fungi. Rastogi & Co., Meerut.
- Dube, H.C. 1990. An Introduction to Fungi, Vikas Publishing House Pvt.Ltd., Delhi.
- Clifton, A. 1958. Introduction to the Bacteria: McGraw Hill & Co., New York.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
- Willey, J.M., Sherwood, L., Woolverton, C.J, Prescott, L.M. and Willey, J.M. (2011). Prescott's Microbiology. New York, McGraw-Hill.

Semester II (Session 2024-25)

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Theory)**	**Nomenclature**	**Diversity of Archigoniates**
Name of the Course	**Discipline specific Course (DSC A2)**	**Course Code**	**24BOTM401DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal marks**	**15**
Time of Examination	**03 hrs.**	**External marks**	**35**

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course objectives:

To understand the diversified habitats, salient features, life cycle and economic importance of archegoniates (Bryophytes, Pteridophytes and Gymnosperms) also to collect and preserve the archegoniates

Course Learning Outcomes (CLO): After completion of this course, the students must be able to acquaint themselves with the following concepts of Botany:

CLO1: Identification, classification, reproduction and economic importance of Bryophytes, Pteridophytes and Gymnosperms

CLO2: Evolution of sporophytes, steles and seed-habit.

CLO3: Geological time scale for understanding the evolution of plants (gymnosperms and angiosperms).

CLO4: The process of fossilization and some early fossil plants.

Unit 1

Bryophytes: General characters; adaptations to land habit; classification upto classes (Smith,1935); range of thallus organization; alternation of generations; evolution of sporophytes; economic importance

Morphology, anatomy and reproduction of *Marchantia* (Hepaticopsida), *Anthoceros* (Anthocerotopsida) and *Funaria* (Bryopsida)

Unit 2

Pteridophytes: General characters; classification (upto classes); alternation of generations; heterospory and seed habit; apospory and apogamy; stelar evolution; economic importance.

Morphology, anatomy and reproduction of *Rhynia* (Psilopsida), *Selaginella* (Lycopsida), *Equisetum* (Sphenopsida) and *Pteris* (Pteropsida).

Unit 3

Palaeobotany: Palaeobotany- Fossils and Fossilization (Process involved, types of fossils and importance of fossils); Reconstruction of the fossil plants: *Lyginopteris, Williamsonia, Cycadeoidea (Bennettites*); origin and evolution of Gymnosperms; Geological Time Table scale

Unit 4

Gymnosperms: General characters; Pilger and Melchior's (1954) system classification of Gymnosperms; Morphology and anatomy of root, stem, leaf/leaflet and reproductive parts including mode of reproduction, life-cycle and economic importance of *Cycas, Pinus* and *Ephedra;* economic importance

Semester II (Session 2024-25)

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper1(Practical)**	**Nomenclature**	**Diversity of Archigoniates**
Name of the Course	**Discipline Specific Course (DSC A2)**	**Course Code**	**24BOTM401DS01**
Hours per Week	**04**	**Maximum Marks**	**50**
Credits	**02**	**Internal Assessment**	**15**
Time of Examination	**03 hrs.**	**Internal Exam**	**35**

Note:

1. Students should draw figures or diagrams and write related descriptions/ notes in their practical note books.

2. Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and/ or specimens related to Archegoniates

Course objectives:

To understand the diversified habitats, salient features, life cycle and economic importance of archegoniates (Bryophytes, Bteridophytes and Gymnosperms) also to collect and preserve the archegoniates

Course Learning Outcomes (CLO): After completion of this course, the students must be able to acquaint themselves with the following concepts of Botany:

CLO1: Identification, classification, reproduction and economic importance of Bryophytes, Pteridophytes and Gymnosperms

CLO2: Evolution of sporophytes, steles and seed-habit.

CLO3: Geological time scale for understanding the evolution of plants (gymnosperms and angiosperms).

CLO4: The process of fossilization and some early fossil plants.

List of Practical:

1. ***Marchantia***- morphology of thallus, WM rhizoids and scales, VS thallus with gemma cup, WM gemmae, VS of antheridiophore and archegoniophore, LS sporophyte (temporary/ permanent slides)
2. ***Anthoceros***- morphology of thallus, WM rhizoids, VS thallus, VS Antheridia and Archegonia, LS sporophyte (temporary/ permanent slides)
3. ***Funaria***- morphology, WM leaf, rhizoids, operculum, peristome, annulus, spores, slides showing antheridial and archegonial heads, LS capsule (temporary/ permanent slides)
4. ***Selaginella***- morphology, WM leaf with ligule, TS stem, WM strobilus, WM microsporophyll and megasporophyll, LS strobilus (temporary/ permanent slide)
5. ***Equisetum***- morphology, TS internode, LS strobilus, TS strobilus, WM sporangiophore, WM spores (wet and dry) (temporary slides); TS rhizome (permanent slide)
6. ***Pteris***- morphology, TS rachis, VS sporophyll, WM sporangium, WM spores, TS rhizome, WM prothallus with sex organs and young sporophyte (temporary/ permanent slide)
7. ***Cycas***- morphology (coralloid roots, bulbil, leaf), TS coralloid root, TS rachis, VS leaflet, VS microsporophyll, WM spores, LS ovule, TS root, LS Seed (temporary/ permanent slide)
8. ***Pinus***- morphology (long and dwarf shoots, WM dwarf shoot, male and female), WM dwarf shoot, TS needle, TS stem, LS/TS male cone, WM microsporophyll, WM microspores (temporary slides), LS female cone, LS Seed (temporary/ permanent slide)
9. ***Ephedra* –** morphology of stem, TS root, TS stem, LS/TS male strobilus, LS microsporangium, LS female strobilus, LS Seed temporary/ permanent slide)
10. Microtomic technique for permanent slide preparation
11. Excursions and field visit for plant collection

Pattern of Practical examination

1. Identify, classify and write short morphological note giving well labelled diagrams on the given two specimens from Bryophytes, Pteridophytes and Gymnosperms (9)
2. Preparation of temporary slide from given material (Bryophytes & Pteridophytes) (4)
3. Preparation of permanent slide from given material (Gymnosperms) (4)
4. Identify giving two important characters of identification of the given spots 1, 2, 3. (6)
5. Field Visit and collection records (4)
6. Practical records (4)
7. Viva-voce (4)

References/ Suggested readings:

1. Bhatnagar, S.P. and Moitra, A. (1996) Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
2. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
3. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005) Biology. Tata McGraw Hill, Delhi, India.
4. Thakur, A.K. and Bassi, S.K. (2008) Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
5. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010) Pteridophyta, S. Chand. Delhi, India

Semester: III

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Theory)**	**Nomenclature**	**Plant Taxonomy**
Name of the Course	**Discipline Specific Course (DSC A3)**	**Course Code**	**25BOTM403DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal marks**	**15**
Time of Examination	**03 hrs.**	**External marks**	**35**

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Objectives: To learn taxonomy and systematics

Course Learning Outcomes (CLO): After completion of this course, the students will be able to acquaint themselves with the following concepts:

CLO 1: Fundamental components of taxonomy

CLO 2: Role of chemotaxonomy, cytotaxonomy and taximetrics in relation to taxonomy

CLO 3: Botanical nomenclature, principles and rules

CLO 4: Taxomnomic keys for identification of plants

CLO 5: Systems of classification of angiosperms proposed by Bentham & Hooker and Engler & Prantl

CLO 6: Floral terms and types of Inflorescence

CLO 7: Diagnostic features and economic importance of dominant angiospermic families

Unit 1

Taxonomy and Systematics, Fundamental components of taxonomy (identification, classification,

description, nomenclature and phylogeny; Role of chemotaxonomy, cytotaxonomy and taximetrics in relation to taxonomy, Botanical nomenclature, principles and rules, principle of priority, Type concept, taxonomic ranks, Keys to identification of plant.

Unit 2

Type concept, taxonomic ranks, Salient features of the systems of classification of angiosperms proposed by Bentham & Hooker and Engler& Prantl, Floral Terms and Types of Inflorescences. BSI, NBPGR, NBRI. Indian contribution in plant taxonomy

Unit 3

Biodiversity hotspots: Global and Indian perspectives

Diversity of Flowering Plants: Diagnostic features and economic importance of the following families: Ranunculaceae, Brassicaceae, Malvaceae, Euphorbiaceae, Rutaceae, Fabaceae and Cucurbitaceae

Unit 4

Diversity of Flowering Plants: Diagnostic features and economic importance of the following families: Rosaceae, Apocyanaceae, Apiaceae, Asclepiadaceae, Lamiaceae, Solanaceae, Asteraceae, Liliaceae and Poaceae

Semester: III

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Practical)**	**Nomenclature**	**Plant Taxonomy**
Name of the Course	**Discipline Specific Course (DSC A3)**	**Course Code**	**25BOTM403DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal Assessment**	**15**
Time of Examination	**03hrs.**	**Internal Exam**	**35**
Note:			
Course Objectives: To learn taxonomy and systematics			
Course Learning Outcomes (CLO): After completion of this course, the students will be able to acquaint themselves with the following concepts: **CLO 1:** Fundamental components of taxonomy **CLO 2:** Role of chemotaxonomy, cytotaxonomy and taximetrics in relation to taxonomy **CLO 3:** Botanical nomenclature, principles and rules,			

CLO 4: Taxonomic keys for identification of plants

CLO 5: Systems of classification of angiosperms proposed by Bentham & Hooker and Engler & Prantl

CLO 6: Floral terms and types of Inflorescence

CLO7: Diagnostic features and economic importance of dominant angiospermic families

List of Practical:

1. Study of floral characteristics of the locally available representatives of the following families: Ranunculaceae, Brassicaceae, Malvaceae, Euphorbiaceae, Rutaceae, Fabaceae, Cucurbitaceae, Apiaceae, Asclepiadaceae, Lamiaceae, Solanaceae, Asteraceae, Liliaceae and Poaceae
2. Identification of selected taxa using taxonomic keys.
3. Field trips/ excursions to explore and identify local flora.
4. Training to use flora and herbarium for identification and classification.
5. Preparation of herbarium of locally available wild plants.

Pattern of Practical Examination:

1. Describe/compare the given flowers A and B in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and floral formulae. Identify and assign them to their respective families giving reasons of each taxon (12)
2. Design a taxonomic key for identification of the given specimen C. (4)
3. Identify by giving the important characters of identification of the spots 1 and 2. (4)
4. Field visit and collection record of locally available plants in the form of herbarium. (5)
5. Practical record (5)
6. Viva-voce (5)

References/Suggested readings:

1. Davis, P.H. and Heywood, V.M. 1973. Principles of Angiosperm Taxonomy. Robert E. Kereiger Publ., New York.
2. Grant, W.F. 1984. Plant Biosystematics. Academic Press, London.
3. Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
4. Radford, A.E. 1986. Fundamentals of Plant Systematics, Harper & Row Publ,. USA.
5. Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd ed.) Edward Arnold Ltd. London.
6. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia Univ. Press, New York.
7. Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. Plant Systematics for 21st Century. Portland Press Ltd. London
8. Singh, G. 2005. Plant Systematics: Theory and Practices (2nd Ed.). Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi
9. Sambamurty, A.V.S.S. 2005. Taxonomy of Angiosperms. I.K. International Pvt. Ltd., New Delhi.
10. Naik, V.N. 2006. Taxonomy of Angiosperms. Tata McGraw Hill Education Pvt. Ltd., New Delhi.
11. Sharma, O.P. 2009. Plant Taxonomy. Tata McGraw Hill Education Pvt. Ltd., New Delhi.
12. Verma, B.K. 2011. Introduction to Taxonomy of Angiosperms. PHI Learning Pvt.Ltd., New Delhi

Semester: IV

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper1 (Theory)**	**Nomenclature**	**Plant Anatomy and Reproductive Biology**
Name of the Course	**Discipline Specific Course (DSC A4)**	**Course Code**	**25BOTM404DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal marks**	**15**
Time of Examination	**03hrs.**	**External marks**	**35**

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Objectives:

Course Learning Outcomes (CLO):

After completion of this course, the students will be able to acquaint themselves with the following concepts of Botany:

CLO1: Tissues- meristematic and permanent (simple, complex and secretory); Tissue systems (epidermal, ground and vascular)

CLO2: Histological organizations of shoot and root apical meristem, Cambium - structure and functions

CLO3: Secondary growth in dicot stem and root, anomalous secondary growth and structural modifications in roots

CLO4: Anatomy of typical monocot and dicot leaf and cell inclusions in leaves

CLO5: Microsporangium, microsporogenesis, pollen grains and its structure, microgametogenesis

CLO7: Pollen-pistil interaction; self- incompatibility, types of Pollination

CLO8: Megasporangium, megasporogenesis and megagametogenesis

CLO9: Double fertilization, Endosperm, Embryogenesis in Dicot and Monocot;

CLO10: Fruit types; Dispersal mechanisms in fruits and seeds.

Unit 1

Tissues - meristematic and permanent (simple, complex and secretory); Tissue systems (Epidermal, ground and vascular)

The Shoot system – Histological organizations of shoot apical meristem;

Cambium - structure and functions; Secondary growth in dicot stem; Anomalous secondary growth (*Dracaen, Boerhaavia, Achyranthus* and *Salvadora)*

Unit 2

Leaf- Anatomy of typical Monocot and Dicot leaf; cell inclusions in leaves; Stomatal apparatus and their morphological types, modifications of leaves and Secondary functions of leaves

Root system- Histological organizations of root apical meristem; Secondary growth in dicot root; Functions of roots, Structural modifications in roots: Storage (*Beta*), Respiratory (*Rhizophora*), Epiphytic (*Vanda*)

Unit 3

Flower-a modified shoot, Development of anther, Microsporogenesis, Microsporangium -structure and dehiscence mechanism. pollen grain and its structure (pollen wall), Pollen germination (microgametogenesis), Male gametophyte, Pollen-pistil interaction; self incompatibility, Pollination: types and agencies. Evolutionary aspects of pollination.

Unit 4

Structure of Megasporangium (ovule) and its types; Megasporogenesis and Megagametogenesis, Female gametophyte (mono, bi and tetrasporic), Double fertilization and its biological importance, Endosperm types. Embryogenesis in Dicot and Monocot; Polyembryony, Structure of Dicot and Monocot seed, Fruit types; Dispersal mechanisms in fruits and seeds.

Semester: IV

Name of Program	**Bachelor of Scienc (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Practical)**	**Nomenclature**	**Plant Anatomy and Reproductive Biology**
Name of the Course	**Discipline Specific Course (DSC A4)**	**Course Code**	**25BOTM404DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal Assessment**	**15**
Time of Examination	**03 hrs.**	**Internal Exam**	**35**
Note:			
Course Objectives:			

Course Learning Outcomes (CLO): After completion of this course, the students will be able to acquaint themselves with the following concepts of Botany:

CLO1: Tissues- meristematic and permanent (simple, complex and secretory); Tissue systems (epidermal, ground and vascular)

CLO2: Histological organizations of shoot and root apical meristem, Cambium - structure and functions

CLO3: Secondary growth in dicot stem and root, anomalous secondary growth and structural modifications in roots

CLO4: Anatomy of typical monocot and dicot leaf and cell inclusions in leaves

CLO5: Microsporangium, microsporogenesis, pollen grains and its structure, microgametogenesis

CLO7: Pollen-pistil interaction; self- incompatibility, types of Pollination

CLO8: Megasporangium, megasporogenesis and megagametogenesis

CLO9: Double fertilization, Endosperm, Embryogenesis in Dicot and Monocot;

CLO10: Fruit types; Dispersal mechanisms in fruits and seeds.

List of Practical:

1. Study of various meristems and plant tissues by permanent and temporary slides.
2. Identification of plant organs on the basis of anatomy
3. Study of anatomy of root, stem and leaves by double staining method
4. Study of microsporogenesis and gametogenesis in sections of anthers.
5. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Tradescantia, Crotolaria, Brassica, Petunia, Solanum melongena*, etc.).
6. Field study of several types of flowers with different pollination mechanisms (wind pollination, water pollination, bee/butterfly pollination, bird pollination).
7. Study of nuclear and cellular endosperm through permanent slides.
8. Isolation of zygotic globular, heart shaped, torpedo stage and mature embryos from suitable seeds.
9. To study polyembryony in citrus, jamun, etc. by dissections.
10. Study of seed dormancy and methods to break dormancy.

Pattern of Practical Examination:

1. Cut the section of given material A and prepare a double stained permanent mount of the given material. Identify giving reasons and show it to the examiner. (8)
2. Identify and give important characters of identification of the spots/specimen 1 and 2 from anatomy and 3 and 4 from embryology. (8)
3. Dissect out the globular/heart-shaped embryo from the given material. Draw the diagram and write characteristic features. (5)
4. Collection of wild monocot/dicot seeds (minimum 16 seeds) with systematic position of respective plant. (4)
5. Practical record (5)
6. Viva voce (5)

References/Suggested readings:

1. David F. Cutler *et. al.* 2007. Plant Anatomy: An Applied Approach, Wiley-Blackwell.
2. William C. Dickison 2000. Integrative Plant Anatomy, Academic Press.
3. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms. 4th revised and enlarge edition. Vikas Publishing House, Delhi.
4. Cutter, E.G. 1969. Plant Anatomy Part-I, Cells and Tissues, Edward Arnold, London.\Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/Cummings Publishing

Company Inc. Menlo Park, California, USA

5. Proctor, M and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London.
6. Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants. 5th edition. W.R. Freeman and Co., Worth Publishers, New York.
7. Thomas, P. 2000. Trees: Their Natural History. Cambridge University Press, Cambridge

Semester: V

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Theory)**	**Nomenclature**	**Plant Physiology**
Name of the Course	**Discipline Specific Course (DSC A5)**	**Course Code**	**26BOTM405DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal marks**	**15**
Time of Examination	**03hrs**	**External marks**	**35**

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Objectives: Students should be able to explain the relationship between plant structure and physiological processes, describe mechanisms of water and nutrient transport, analyze biochemical pathways of photosynthesis and understand the role of growth regulators in plant development.

Course Learning Outcomes (CLO):

After completion of this course, the students will be able to acquaint themselves with the following concepts of Botany:

CLO1: Explain the significance of water in plant life, mechanisms of water and mineral uptake and their role in plant physiology.

CLO 2: Describe the process of photosynthesis, including pigment function, carbon fixation pathways and factors affecting translocation in plants.

CLO 3: Interpret the phases of plant growth, the role of photoperiodism in flowering and the physiological processes of senescence and fruit ripening.

CLO 4: Compare the major plant hormones and phytochromes in terms of their discovery, physiological roles and mechanisms of action in plant development.

CLO 5: Compare various types of movements occurring in plants.

Unit 1

Plant-water relations: Importance of water to plant life; physical properties of water; imbibition, diffusion and osmosis; absorption and transport of water; transpiration; physiology of stomata.

Mineral nutrition: Essential macro and microelements and their role; mineral uptake; deficiency symptoms.

Unit 2

Transport of organic substances: Mechanism of phloem transport; source-sink relationship; factors affecting translocation.

Photosynthesis: Significance; historical aspects; photosynthetic pigments; action spectra and enhancement effects; concept of two photosystems; Z-scheme; photophosphorylation;Calvin cycle; C4 pathway; CAM plants; photorespiration.

Unit 3

Growth and development: Definitions; phases of growth and development.

Plant Movements - Autonomic (Growth: Nutation, Nodding, Circumnutation; **Turgor:** Circumnutation, Pulvinar and **Variation:** Nyctinasty and Rhythmic**)** and **Paratonic (Tropic:** Phototropism, Geotropism, Hydrotropism, Thigmotropism, Chemotropism; **Nastic:** Photonasty, Nyctinasty, Seismonasty, Thermonasty, Chemonasty and **Tactic:** Phototactic, Chemotactic, Hydrotactic**).**

Physiology of flowering: Florigen, Photoperiodism and Biological clocks.

Physiology of senescence.

Unit 4

Plant hormones: auxins, gibberellins, cytokinins, abscissic acid and ethylene, history of their discovery, mechanism of action, applications; photo-morphogenesis.

Discovery, physiological role and mechanism of action of **phytochromes** and **cryptochromes**.

Semester: V

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper 1 (Practical)**	**Nomenclature**	**Plant Physiology**
Name of the Course	**Discipline Specific Course (DSC A5)**	**Course Code**	**26BOTM405DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal Assessment**	**15**
Time of Examination	**03 hrs.**	**Internal Exam**	**35**
Note:			
Course Objectives: Students should be able to explain the relationship between plant structure and			

physiological processes, describe mechanisms of water and nutrient transport, analyze biochemical pathways of photosynthesis and understand the role of growth regulators in plant development.

Course Learning Outcomes (CLO):

After completion of this course, the students will be able to acquaint themselves with the following concepts of Botany:

CLO1: Explain the significance of water in plant life, mechanisms of water and mineral uptake and their role in plant physiology.

CLO 2: Describe the process of photosynthesis, including pigment function, carbon fixation pathways and factors affecting translocation in plants.

CLO 3: Interpret the phases of plant growth, the role of photoperiodism in flowering and the physiological processes of senescence and fruit ripening.

CLO 4: Compare the major plant hormones and phytochromes in terms of their discovery, physiological roles and mechanisms of action in plant development.

CLO 5: Compare various types of movements occurring in plants.

List of Practical:

1. Demonstration of open and closed stomata.
2. Determination of water potential using the potato tuber method.
3. Measurement of transpiration rate using a Ganong'spotometer.
4. Demonstration of osmosis by potato osmoscope method.
5. Demonstration of imbibition by Plaster of Paris (PoP) method.
6. Study of stomatal density and stomatal index using leaf epidermal peels.
7. Study of deficiency symptoms in plants grown in nutrient-deficient solutions (hydroponics).
8. Demonstration of phloem translocation using girdling experiments.
9. Extraction and separation of photosynthetic pigments using paper chromatography.
10. Estimation of chlorophyll content in leaves using a spectrophotometer.
11. Effect of photoperiod on flowering using short-day and long-day plants.
12. Demonstration of phototropism and geotropism in seedlings.
13. Demonstration of Hydrotropism in seedling roots
14. Effect of temperature on seed germination and plant growth.
15. Effect of gibberellins on seed germination and stem elongation.
16. Effect of abscisic acid on stomatal closure using epidermal peel mounts.
17. Study of phytochrome-mediated seed germination in light-sensitive seeds.

Pattern of Practical Examination:

1. **Major Experiments (13 Marks):**

Devise an experiment to demonstrate the physiological process. Perform and show it to the examiner.

- Determination of water potential using the potato tuber method.
- Measurement of transpiration rate using a Ganong'spotometer.
- Demonstration of phloem translocation using girdling experiments.

- Effect of photoperiod on flowering using short-day and long-day plants.
- Demonstration of osmosis by potato osmoscope method.
- Extraction and separation of photosynthetic pigments using paper chromatography.
- Estimation of chlorophyll content in leaves using a spectrophotometer.
- Demonstration of imbibition by PoP method.

2. Minor Experiments (8 Marks):

Comment on the given physiological experiment.

- Demonstration of phototropism and geotropism in seedlings.
- Demonstration of hydrotropism in seedling roots.
- Effect of temperature on seed germination and plant growth.
- Effect of gibberellins on seed germination and stem elongation.
- Study of phytochrome-mediated seed germination in light-sensitive seeds.

3. Spotting (4 Marks – Two Spots, 2 Marks Each)

- Demonstration of open and closed stomata.
- Study of stomatal density and stomatal index using leaf epidermal peels.
- Study of deficiency symptoms in plants grown in nutrient-deficient solutions (hydroponics).
- Effect of abscisic acid on stomatal closure using epidermal peel mounts.

4. Practical Record (5 Marks)

5. Viva-voce (5 Marks)

References/Suggested readings:

1. Buchanan, B.B., Gruissem, W., and Jones, R.L. (2015): *Biochemistry and Molecular Biology of Plants (2nd Edition)*, Wiley-Blackwell, USA.
2. Hopkins, W.G., and Hüner, N.P.A. (2008): *Introduction to Plant Physiology (4th Edition)*, Wiley, USA.
3. Jain, V.K. (2017): *Fundamentals of Plant Physiology (19th Edition)*, S. Chand Publishing Co., New Delhi, India.
4. Kochhar, S.L., and Gujral, S.K. (2019): *Plant Physiology: Theory and Applications*, Cambridge University Press, Cambridge, UK.
5. Lambers, H., Chapin III, F.S., and Pons, T.L. (2008): *Plant Physiological Ecology (2nd Edition)*, Springer, New York, USA.
6. Taiz, L., Zeiger, E., Møller, I.M., and Murphy, A. (2021): *Plant Physiology and Development (7th Edition)*, Oxford University Press, USA.
7. Verma, S.K., and Verma, M. (2007):*A Textbook of Plant Physiology and Biochemistry*

Semester: VI

Name of Program	Bachelor of Science (Life Sciences)	Program Code	UMLS4
Paper No.	Paper1 (Theory)	Nomenclature	Plant Biochemistry and Metabolism
Name of the Course	Discipline Specific Course (DSC A6)	Course Code	26BOTM406DS01
Hours per Week	02	Maximum Marks	50
Credits	02	Internal marks	15
Time of Examination	03hrs	External marks	35

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Objectives: To understand the fundamentals of enzymology, respiration, lipid and nitrogen metabolism, secondary metabolites, plant stress responses, fruit and seed physiology, with emphasis on biochemical mechanisms and their physiological significance.

Course Learning Outcomes (CLO): After completion of the course, the students will be able to:

CLO 1: Explain enzyme nomenclature, structure, function and mechanisms, including factors regulating enzyme activity.

CLO 2: Understand ATP generation, the biochemical pathways of aerobic and anaerobic respiration and the mechanisms of oxidative phosphorylation.

CLO 3: Describe lipid biosynthesis, fatty acid metabolism, nitrogen fixation and ammonium assimilation in plants.

CLO 4: Analyze the biosynthesis and roles of secondary metabolites, plant responses to biotic and abiotic stress and the physiological processes of seed dormancy, germination and fruit ripening.

Unit 1

Basics of Enzymology: Discovery and nomenclature; characteristics of enzymes; concept of holoenzyme, apoenzyme, coenzyme and co-factors; regulation of enzyme activity; mechanism of action.

Unit 2

Respiration: ATP – the biological energy currency; aerobic and anaerobic respiration; Krebs cycle; electron transport mechanism (chemiosmotic theory); redox -potential; oxidative phosphorylation; pentose phosphate pathway.

Unit 3

Lipid metabolism: Structure and functions of lipids; fatty acid biosynthesis; β-oxidation; saturated and

unsaturated fatty acids; storage and mobilization of fatty acids.

Nitrogen metabolism: Biology of nitrogen fixation; importance of nitrate reductase and its regulation; ammonium assimilation.

Unit 4

Secondary metabolites: Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

Stress physiology; Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Fruit and seed physiology: Dormancy, storage and germination of seed; Fruit ripening—its molecular basis and manipulation

Semester: VI

Name of Program	**Bachelor of Science (Life Sciences)**	**Program Code**	**UMLS4**
Paper No.	**Paper1 (Practical)**	**Nomenclature**	**Plant Biochemistry and Metabolism**
Name of the Course	**Discipline Specific Course (DSC A6)**	**Course Code**	**26BOTM406DS01**
Hours per Week	**02**	**Maximum Marks**	**50**
Credits	**02**	**Internal Assessment**	**15**
Time of Examination	**03 hrs.**	**Internal Exam**	**35**

Note:

Course Objectives: To understand the fundamentals of enzymology, respiration, lipid and nitrogen metabolism, secondary metabolites, plant stress responses, fruit and seed physiology, with emphasis on biochemical mechanisms and their physiological significance.

Course Learning Outcomes (CLO): After completion of the course, the students will be able to:

CLO 1: Explain enzyme nomenclature, structure, function and mechanisms, including factors regulating enzyme activity.

CLO 2: Understand ATP generation, the biochemical pathways of aerobic and anaerobic respiration and the mechanisms of oxidative phosphorylation.

CLO 3: Describe lipid biosynthesis, fatty acid metabolism, nitrogen fixation and ammonium assimilation in plants.

CLO 4: Analyze the biosynthesis and roles of secondary metabolites, plant responses to biotic and abiotic stress and the physiological processes of seed dormancy, germination and fruit ripening.

List of Practical:

1. Extraction and estimation of enzyme activity (e.g., amylase or peroxidase) from plant tissues.
2. Demonstration of enzyme specificity using starch hydrolysis by amylase.
3. Measurement of respiratory rate in germinating seeds using a respirometer.
4. Demonstration of anaerobic respiration by fermentation in yeast.
5. Demonstration of aerobic respiration.
6. Qualitative analysis of carbohydrates (glucose, sucrose and starch), proteins and fats.
7. Extraction and qualitative analysis of lipids from plant seeds.
8. Estimation of fatty acids using titration or chromatography techniques.
9. Study of plant responses to biotic stress (e.g., pathogen-induced defense reactions).
10. Effect of abiotic stress (drought or salt stress) on plant growth and physiology.
11. Study of seed dormancy-breaking treatments and seed germination experiments.
12. Analysis of fruit ripening stages by measuring changes in sugar and pigment content.
13. Study of seed dormancy and methods to break dormancy (cold treatment, scarification, chemical treatment).

Pattern of Practical Examination:

1. Major Experiment (One experiment) – 15 Marks

- Extraction and estimation of enzyme activity (e.g., amylase or peroxidase) from plant tissues.
- Measurement of respiratory rate in germinating seeds using a respirometer.
- Qualitative analysis of carbohydrates (glucose, sucrose, and starch), proteins and fats.
- Extraction and qualitative analysis of lipids from plant seeds.
- Study of plant responses to biotic stress (e.g., pathogen-induced defense reactions).
- Demonstration of aerobic respiration.
- Study of seed dormancy-breaking treatments and seed germination experiments.

2. Minor Experiment (One experiment to be performed or commented upon) – 10 Marks

- Demonstration of enzyme specificity using starch hydrolysis by amylase.
- Estimation of fatty acids using titration or chromatography techniques.
- Effect of abiotic stress (drought or salt stress) on plant growth and physiology.
- Demonstration of anaerobic respiration by fermentation in yeast.
- Analysis of fruit ripening stages by measuring changes in sugar and pigment content.
- Study of seed dormancy and methods to break dormancy (cold treatment, scarification, chemical treatment).

3. Viva-Voce – 5 Marks

4. Practical Record – 5 Marks

References/Suggested readings:

1. Bhatla, S.C. and Lal, M.A. (2018): *Plant Physiology, Development and Metabolism*, Springer, Singapore.
2. Bowsher, C., Steer, M., and Tobin, A. (2008): *Plant Biochemistry*, Garland Science, Taylor & Francis, New York, USA.
3. Buchanan, B.B., Gruissem, W., and Jones, R.L. (2015): *Biochemistry & Molecular Biology of Plants*, Wiley-Blackwell, USA.
4. Lea, P.J. and Leegood, R.C. (1999): *Plant Biochemistry and Molecular Biology*, John Wiley & Sons, Chichester, England.
5. Taiz, L., Zeiger, E., Møller, I.M., and Murphy, A. (2015): *Plant Physiology and Development*, Sinauer Associates, Oxford University Press, USA.
6. Lea, P.J. and Leegood, R.C. (1999): *Plant Biochemistry and Molecular Biology*, John Wiley & Sons, Chichester, England.