SUMMARY OF CREDITS IN BOTANY								
DEPARTMENT OF BOTANY (UG) CBZ 2024-27								
Semester	**Code Number**	**Title**	**No. of Hrs of Instructions**	**No. of Hrs of teaching per week**	**No. of credits**	**Continuous Internal Assessment (CIA)**	**End Semester Marks**	**Total marks**
1	BO1124	Microbiology, Mycology and Plant Pathology	45	3	3	40	60	100
1	BO1P124	Microbiology, Mycology and Plant Pathology	33	3	2	25	25	50
2	BO2124	Phycology and Bryology	45	3	3	40	60	100
2	BO2P124	Phycology and Bryology	33	3	2	25	25	50
3	BO3125	Pteridophytes, Gymnosperms and Plant Anatomy	45	3	3	40	60	100
3	BO3P125	Pteridophytes, Gymnosperms and Plant Anatomy	33	3	2	25	25	50
4	BO4125	Palynology and Embryology of Angiosperms	45	3	3	40	60	100
4	BO4P125	Palynology and Embryology of Angiosperms	33	3	2	25	25	50
DEPARTMENT OF BOTANY (UG) CBBT 2024-27								
1	BO1224	Virology, Bacteriology, Mycology and Phytopathology	45	3	3	40	60	100
1	BO1P224	Virology, Bacteriology, Mycology and Phytopathology	33	3	2	25	25	50
2	BO2224	Applied Phycology and Bryology	45	3	3	40	60	100
2	BO2P224	Applied Phycology and Bryology	33	3	2	25	25	50
3	BO3225	Plant Anatomy, Paleobotany and Palynology	45	3	3	40	60	100
3	BO3P225	Plant Anatomy, Paleobotany and Palynology	33	3	2	25	25	50
4	BO4225	Pteridophytes and Gymnosperms	45	3	3	40	60	100
4	BO4P225	Pteridophytes and Gymnosperms	33	3	2	25	25	50
DEPARTMENT OF BOTANY (UG) CBBT and CBZ 2024-27								
5	BO5126	Plant Physiology and Biochemistry	45	3	3	40	60	100
5	BO5P126	Plant Physiology and Biochemistry	33	3	2	25	25	50
5	BO5226	Plant Systematics and Ethnobotany	45	3	3	40	60	100
5	BO5P226	Plant Systematics and Ethnobotany	33	3	2	25	25	50
5	BO5326	Plant Biotechnology and Crop Improvement	45	3	3	40	60	100
5	BO5P326	Plant Biotechnology and Crop Improvement	33	3	2	25	25	50
5	BO5S26	Skill-based Entrepreneurship in Plant Sciences I	33	3	2	25	25	50
5	BO5RM26	Elementary Research Methodology	30	2	2	20	30	50
6	BO6126	Ecology, Forestry and Conservation Science	45	3	3	40	60	100
6	BO6P126	Ecology, Forestry and Conservation Science	33	3	2	25	25	50
6	BO6226	Seed Technology, Plant breeding and Propagation	45	3	3	40	60	100
6	BO6P226	Seed Technology, Plant breeding and Propagation	33	3	2	25	25	50
6	BO6326	Biostatistics, Bioinformatics and Computational Biology	45	3	3	40	60	100
6	BO6P326	Biostatistics, Bioinformatics and Computational Biology	33	3	2	25	25	50
6	BO6S26	Skill-based Entrepreneurship in Plant Sciences II	33	3	2	25	25	50
6	BO 6PR26	Research Project and Dissertation	66	03+03	4	50	50	100

ST JOSEPH'S UNIVERSITY

BENGALURU-27

Re-accredited with 'A++' GRADE with 3.79/4 CGPA by NAAC Recognized by UGC as College of Excellence

BOTANY SYLLABUS

FOR UNDERGRADUATE PROGRAMME - CBZ

(AS PER SEP 2024-27)

Semester	**I- CBZ**
Paper Code	**BO 1124**
Paper Title	**Microbiology, Mycology and Plant Pathology**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practical per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	The course aims to: 1. Provide a basic understanding of contributions of key microbiologists in shaping the field. 2. Explain the components, working principles, and applications of light and electron microscopes. 3. Explain the preparation and application of basal, enriched, selective, indicator, transport, and storage media. 4. Appreciate the diversity and significance of viruses in biological systems. 5. Evaluate the economic importance of bacteria in industry, agriculture, and medicine. 6. Appreciate the significance of plant pathology in agriculture and food security.
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to 1. Analyze the impact of historical discoveries on the advancement of microbiology. 2. Identify the components and working principles of simple, compound, and electron microscopes (SEM and TEM). 3. Compare various sterilization techniques, including dry heat, moist heat, UV light, ionizing radiation, and filtration. 4. Understand the role of viruses in disease and biotechnology. 5. Assess the economic importance of bacteria and fungi in industry, agriculture, and medicine. 6. Explain the impact of plant diseases on agriculture and food security.

BO 1124: Microbiology, Mycology and Plant Pathology

Units	Title of Contents	Hrs (45)
UNIT I	**History and developments of microbiology -** Microbiologists and their contributions (Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner and Alexander Fleming).	**2**
UNIT II	**Microscopy –** *History of microscopy (self study).* Components, working principle and applications of light *(simple and compound) (self study)* and electron microscopes (SEM and TEM).	**3+*2***
UNIT III	Culture media for Microbes - *Natural and synthetic media, Routine media -basal media, enriched media, selective media, indicator media, transport media, and storage media (Self study)*	***2***
UNIT IV	**Sterilization methods -** Principle of disinfection, antiseptic and Pasteurization, Sterilization - Sterilization by dry heat, moist heat, UV light, ionization radiation, filtration. Chemical methods of sterilization - phenolic compounds, anionic and cationic detergents.	**4**
UNIT V	**Viruses** - General structure and classification based on Nucleic acids (ssDNA, dsDNA, ssRNA, and dsRNA). Structure and multiplication of TMV.	**3**
UNIT VI	**Bacteria** – General account on Archaebacteria and Eubacteria. General characteristics and classification of bacteria based on shape and flagellation. Ultrastructure of Bacteria - Structure of capsule, flagella, pili and endospore. (Ultrastructure of flagella and endospore only), Physical and chemical structure of Gram positive and Gram- negative bacterial cell walls. Reproduction by binary fission. Genetic recombination by conjugation (F+ and F-, Hfr types), Transduction (generalized and specialized types) and Transformation. *Economic importance of Bacteria (Industry, agriculture and Medicine) – (self study)*	**13+*1***
UNIT VII	**Fungi** - General characteristics and thallus organization and nutrition in fungi. Reproduction in fungi (asexual and sexual). Type study of; *Pythium*, *Rhizopus*, *Puccinia* and *Penicillium*. *Economic importance of fungi (Industry, agriculture and medicine) – Self study* **Lichens** – Structure, types and reproduction.	**9+*1***
UNIT VIII	**Plant Pathology** – Brief account of the following diseases: Tomato Leaf Curl, Citrus Canker, Sandal Spike, Club Root of Crucifer, Smut of Jowar, Blast of Rice, Red Rot of Sugarcane.	**5**

Note: Portions that are underlined are meant for self-study

BO 1P1 24: Microbiology, Mycology and Plant Pathology

11 Sessions – 3 Hours/ Week

Sl. No.	Experiments	Units/ Sessions
1	Safety measures in microbiology laboratory and study of equipment/appliances used for microbiological studies (Microscopes, Hot air oven, Autoclave/Pressure Cooker, Inoculation needles/loop, Petri plates, Incubator, Laminar flow hood, Colony counter).	1
2	Preparation of culture media (NA/PDA) sterilization, inoculation. Enumeration of soil/water microorganisms by serial dilution technique.	1
3	Gram's staining of bacteria	1
4	Determination of cell count by using Haemocytometer.	1
5	Determination of microbial cell dimension by using Micrometer.	1
6	Study of vegetative structures and reproductive structures – *Stemonitis, Pythium, Rhizopus*	1
7	Study of vegetative structures and reproductive structures- *Puccinia, Penicillium*	1
8	Study of vegetative structures and reproductive structures- *Trichoderma* and *Agaricus*	1
9	Study of Tomato Leaf Curl, Citrus Canker, Sandal Spike, Club Root of Crucifer.	1
10	Study of Smut of Jowar, Blast of Rice, Red Rot of Sugarcane and Tikka disease of Groundnut. Revision.	2

References

1. Ananthnarayan R and Panikar JCK. 1986. Text book of Microbiology. Orient Longman ltd. New Delhi.
2. Arora DR. 2004. Textbook of Microbiology, CBS, New Delhi.
3. William CG. 1989. Understanding microbes. A laboratory text book for Microbiology. W.H.
4. Freeman and Company. New York.
5. Dubey RC and Maheshwari DK. 2007. A textbook of Microbiology, S. Chand and Company, New Delhi.
6. Dubey RC and Maheshwari DK. 2002. A Text book of Microbiology, S.C. Chand and Company, Ltd. Ramnagar, New Delhi.

7. Sharma R. 2006. Text book of Microbiology. Mittal Publications. New Delhi. 305pp.
8. Sharma PD. 1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
9. Vasanthkumari R. 2007. A textbook of Microbiology, BI Publications Pvt. Ltd., New Delhi.
10. Alexepoulos CJ and Mims CW. 1989. Introductory Mycology, Wiley Eastern Ltd., New Delhi.
11. Allas RM. 1988. Microbiology: Fundamentals and Applications, Macmillan publishing co. New York.
12. Brook TD, Smith DW and Madigan MT. 1984. Biology of Microorganisms, 4th ed. Eaglewood Cliffts. N.J. Prentice-Hall. New Delhi.
13. Burnell JH and Trinci APJ. 1979. Fungal walls and hyphal growth, Cambridge University Press. Cambridge.
14. Jayaraman J. 1985. Laboratory Manual of Biochemistry, Wiley Eastern Limited. New Delhi.
15. Ketchum PA. 1988. Microbiology, concepts and applications. John Wiley and Sons. New York.
16. Michel J, Pelczar Jr.EC and Krieg CR. 2005. Microbiology, Mc.Graw-Hill, New Delhi.
17. Powar CB and Daginawala. 1991. General Microbiology, Vol – I and Vol – II Himalaya publishing house, Bombay.
18. Reddy S and Ram. 2007. Microbial Physiology. Scientific Publishers, Jodhpur, 385pp.
19. Sullia SB and Shantharam S. 1998. General Microbiology. Oxford and IBH publishing Co. Pvt. Ltd. New Delhi.
20. Schlegel HG. 1986. General Microbiology. Cambridge. University Press. London, 587pp.
21. Roger S, Ingrahan Y, Wheelis JL, Mark L and Page PR. 1990. Microbial World 5th edition. Prentice-Hall India, Pvt. Ltd. New Delhi.

PRACTICAL EXAMINATION QUESTION PAPER PATTERN

ST. JOSEPH'S UNIVERSITY, BENGALURU - 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
I B.Sc. I SEMESTER - CBZ
BO 1P1 24- MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY
BOTANY PRACTICAL EXAMINATION

MAX. MARKS: 25 **TIME: 3 HOURS**

I	Perform the Gram's staining for **A.** Write the principle, identify with reasons and leave the preparation for evaluation	2+2=4
II	Calculate the population of yeast cells using haemocytometer/ measure cell dimensions using micrometer in the given sample **B**. Briefly describe the instrument and tabulate the result.	2+2=4
III	Identify and classify the specimens **C** and **D** with reasons.	2X2.5=5
IV	Identify the slides **E** and **F** with labeled diagrams and reasons.	2X3=6
V	Comment on spotters **G, H** and **I**	2X3=6

KEY

A – Curd sample/Root nodule extract

B – Haemocytometry - Yeast cells. Micrometry - Pollen or Epidermal cells or Fungal spores

C & D – Fungal specimens

E & F – Fungal slides

G, H and I – Plant pathology specimen/ slide, Microbiological instrument, Serial dilution/ Culture plate

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
I B.Sc. BOTANY – I SEMESTER, CBZ
SEMESTER EXAMINATION
BO 1124: MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

Time: 2 Hours **Max Marks: 60**

The paper contains TWO printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	02	04
II	05	10
III	02	04
IV	04	08
V	03	06
VI	14	24
VII	10	20
VIII	05	10
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**II – CBZ**
Paper Code	**BO 2124**
Paper Title	**Phycology and Bryology**
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of theory credits	03
Total number of teaching hours of practicals per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	The course aims to 1. Describe the diversity, classification, and reproduction of algae, with reference to their habitat and thallus organization. 2. Analyze the systematic position, structure, and reproductive methods of selected algae species. 3. Evaluate the economic importance of algae in ecosystems, identifying both their harmful and beneficial effects. 4. Understand the general characteristics, distribution, and classification of bryophytes, with specific reference to Proskauer's classification system. 5. Discuss the ecological role of bryophytes, including their response to environmental changes, pollution, and conservation efforts
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to 1. Identify different types of algae and describe their life cycle types, including haplontic, diplontic, haplodiplontic, haplobiontic, and diplobiontic cycles. 2. Describe the morphology, anatomy, and reproduction of key bryophyte species belonging to the liverworts, hornworts and true mosses. 3. Examine the phylogenetic relationships between algae and bryophytes, recognizing their evolutionary connections. 4. Assess the impact of pollution on bryophytes and explore their role in bioindication and ecological adaptation. 5. Explore the practical applications of bryophytes and algae, including their use in conservation biology and their role in sustainable agriculture and environmental monitoring.

BO 2124 – Phycology and Bryology

Units	Title of Contents	Hours (45)
UNIT I	**Algae – General concepts** Diversity of Algae with respect to habitat, thallus organization and reproduction. *Classification of algae (upto classes) by Fritsch (self study).* Life cycle types in algae: Haplontic, diplontic, haplodiplontic, haplobiontic and diplobiontic types.	10 + *2*
UNIT II	**Algae – Type study** Systematic position, structure and reproduction of the following forms: *Anabaena, Volvox, Spirogyra, Chara, Vaucheria, Sargassum, Batrachospermum*.	9
UNIT III	*Economic importance of algae including harmful and useful effects in ecosystems (self study).*	*2*
UNIT IV	**Bryophytes – General concepts** Bryophytes: Distribution, general characters, alternation of generation and classification of Bryophytes by Proskauer (1957).	4
UNIT V	**Bryophytes – Type study** Morphology, anatomy and reproduction of *Marchantia, Anthoceros and Sphagnum* (developmental details not required).	7
UNIT VI	Origin and phylogenetic relationships between algae and bryophytes.	2
UNIT VII	Ecology of Bryophytes. Bryophytes in a changing world – impact of pollution on bryophytes, application to bioindication, adaptation to a changing environment. Conservation biology for algae and bryophytes – threats, need for conservation and conservation strategies. Role of peat in soil less plant growth.	7
UNIT VIII	*Economic importance of Bryophytes (self-study).*	*2*
NOTE: Portions that are underlined are meant for self-study		

BO 2P1 24: Phycology and Bryology

11 Sessions – 3 Hours/ Week

Sl. No.	Experiments	Units/ Sessions
1	Type study of *Anabaena, Scytonema, Spirulina*	1
2	Type study of *Volvox, Hydrodictyon*	1
3	Type study of *Spirogyra, Chara*, *Vaucheria*	1
4	Type study of *Sargassum, Batrachospermum*	1
5	Type study of *Marchantia*	2
6	Type study of *Anthoceros*	1
7	Type study of *Funaria*	1
8	Type study of *Sphagnum*	1
9	Type study of Isolation of algae from water samples by serial dilution method	1
10	Institutional visit to study culturing of microalgae	1

References:

1. Fritsch, FE. 1961. Structure and reproduction in algae,Vol.I and II, camridge UniversityPress, London
2. Trivedi, PC. 2001. Algal biotechnology, Pointer publishers, Jaipur, India.
3. Bold and Wynee, 1985. Introduction to Algae- structure and reproduction; Prentice hall,India.
4. Vashishta, BR. 1976. Botany for degree students Part 1.Algae,S.Chand and company, New Delhi.
5. Parihar, NS.1962. Bryophyta, Central book depot, Allahabad.
6. Srivastava, HN. 1993. Bryophyta, Pradeep Publications, Allahabad.
7. Watson, EV. 1971. The structure and life of Bryophytes, Hutchinson and Co., London.
8. Goffinet, B. and Shaw, J. 2009. Bryophyte biology. Cambridge University press, London.
9. Das, K. Kityania, S. Nath, R. Das, S. Nath, D. and Talukdar, AD. 2022. Bioactive Compounds from Bryophytes. In: H. N. Murthy (ed.), Bioactive Compounds in Bryophytes and Pteridophytes. Springer Nature Switzerland.
10. Henes, B. Zu¨ lli, F. Niederkru¨ ger, H. Schaaf, A. Frischmuth, T. Decker, EL. Reski, R. The magic of moss. Soap Perfumery Cosmet 2018, 91:64-66.
11. Wandrey F, Henes B, Zu¨ lli F, Reski J: Biotechnologically produced moss active improves skin resilience. SOFW J 2018, 144:34-37.
12. Decker, E. L. and Reski, R. 2020. Mosses in biotechnology. Current Opinion in Biotechnology, 61:21–27.
13. Horn, A. Pascal, A. Lončarević, I. Volpatto Marques, R. Lu, Y. Miguel, S.… Simonsen, HT. 2021. Natural Products from Bryophytes: From Basic Biology to Biotechnological Applications. Critical Reviews in Plant Sciences, 40(3), 191–217.
14. Martínez-Abaigar, J. and Núñez-Olivera, E. 2021. Novel biotechnological substances from

bryophytes. In: R. P. Sinha, D-P. Häder (Eds). Natural Bioactive Compounds, Academic Press, 233-248.

PRACTICAL EXAM QUESTION PAPER PATTERN

ST. JOSEPH'S UNIVERSITY, BENGALURU - 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
I B.Sc. II SEMESTER - CBZ
BO 2P1 24 – PHYCOLOGY AND BRYOLOGY
BOTANY PRACTICAL EXAMINATION

MAX. MARKS: 25 TIME: 3 HOURS

I	Identify specimens A, B and C with classification and reasons	3 × 3 = 9
II	Prepare a temporary slide of D, identify, comment and leave the preparation for evaluation	4
III	Identify the slides E, F and G with labeled diagrams and reasons	4 × 3 = 12

KEY

A, B, C – Algae and Bryophyte specimens

D – Algae specimen

E, F, G – Algae and Bryophyte slides

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027

I B.Sc. BOTANY – I SEMESTER, CBZ

SEMESTER EXAMINATION

BO 2124: PHYCOLOGY AND BRYOLOGY

Time: 2 Hours **Max Marks: 60**

The paper contains TWO printed pages and THREE parts

Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Answer ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hours	Total marks for which the questions are to be asked (including bonus questions)
I	11	21
II	9	17
III	2	4
IV	4	8
V	7	14
VI	2	4
VII	7	14
VIII	2	4
TOTAL	45	86
Note: Maximum marks for the paper (Excluding bonus question): 60		

Semester	**III**
Paper Code	**BO 3125**
Paper Title	**Pteridophytes, Gymnosperms and Plant Anatomy**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practical per semester	33
Number of practical credits	02

COURSE OBJECTIVES **(CO)**	CO1: Understanding the basic concepts of classical botany through different life forms and life cycles in Pteridophytes and Gymnosperms. CO2: Understanding interrelationship and evolutionary aspects among life forms of Pteridophytes and Gymnosperms. CO3: Understanding economic uses and bioprospecting of Pteridophytes and Gymnosperms. CO4: Understanding the internal structure of various parts of a plant as well as among different plant groups in support for the evolutionary concept. CO5: Understanding the primary, secondary and anomalous secondary growth in different plant groups and their significance in structural organization. learn
LEARNING OUTCOMES **(LO)**	After completion of the course, the students will be able to - LO1: Remember and apply the learnt knowledge on Pteridophytes and Gymnosperms especially on characteristic features, distribution, and affinities of these plant groups. LO2: Understand and differentiate between gametophytes, sporophytes, reproduction and life cycle of selected Pteridophyte and Gymnosperm

	plants. LO3: Understand and analyze the stelar evolution, the phenomenon of heterospory and seed habit in Pteridophytes. LO4: Demonstrate and develop skills on the internal structural (primary, secondary and abnormal) organization in different plant groups and their relevance with plant evolution. LO5: Demonstrate and develop skills on the internal structural organization of different plant groups based on primary, secondary and abnormal growth conditions and its significance in plant growth and development.

BO 3125: PTERIDOPHYTES, GYMNOSPERMS AND PLANT ANATOMY - 45 Hours		
	Pteridophytes	**15 hrs**
UNIT I	A general account of characteristic features, distribution, and affinities of Pteridophytes with Bryophytes and Gymnosperms. Classification of Pteridophytes (Smith, 1955).	2+1
UNIT II	Systematic position, sporophytic structure (morphology and anatomy), reproduction (developmental stages not required) and life cycle of *Psilotum, Lycopodium, Selaginella, Equisetum,* and *Marsilea.*	8+1
UNIT III	Stelar evolution in Pteridophytes. Heterospory and seed habit. Allergic Ferns and Invasive Ferns (*Pteridium aquilinum*).	3
	Gymnosperms	**15 hrs**
UNIT IV	A general account of characteristic features, distribution, and affinities of Gymnosperms with Angiosperms. Classification of Gymnosperms (Sporne, 1965). Salient features of Cycadales, Coniferales and Gnetales.	4+1
UNIT V	Systematic position, sporophytic structure (morphology and anatomy), reproduction (developmental stages not required) and life cycle of *Pinus* and *Gnetum*. Economic importance of Gymnosperms.	9+1
	Plant Anatomy	**15 hrs**
UNIT VI	**Plant cell**: Ultra-structural organization of plant cell wall (primary and secondary) and functions.	2

UNIT VII	Meristematic tissue and its classification, Simple and complex permanent tissues. Structural organization of Shoot Apical Meristem (SAM) - Theories of organization (Apical cell, Histogen, Tunica-Corpus); Root Apical Meristem (Korper-Kappe theory), and Quiescent centre concept.	5 + 1
UNIT VIII	**Leaf**, **Stem and Root anatomy**: Primary (internal) structure of leaf, root and stem (Dicot and Monocot). Types of vascular bundles. Secondary growth of dicot stem (*Helianthus*) and dicot root (*Cicer*); Anomalous secondary growth in the stem of *Boerhaavia* and *Dracaena*.	6 + 1 hrs

NOTE: Portions that are underlined are meant for self-study

References

Sporne, K.R. (1970). The Morphology of Pteridophytes: The Structure of Ferns and allied Plants. Hutchinson Co., London.

Sundara Rajan, S. (2009). Introduction To Pteridophyta. New Age International Publisher. New Delhi.

Rashid, A. (1999). An Introduction to Pteridophyta, 2/e. Vikas Publishing.

Sharma O. P. (2023). Textbook of Pteridophyta. Medtech Science Press; 2nd edition, New Delhi.

Parihar, N. S. (1977). The Biology and Morphology of the Pteridophytes. Central Book Depot, Allahabad.

Eames, A. J. (1936). Morphology of Vascular Plants-Lower Groups (Psilophytales to Filicales), McGraw Hill, New York.

Bhatnagar, S. P. and Alok Mitra. (1966). Gymnosperms. New Age International (P) Ltd. Publishers.

Chamberlain, C. J. (1935). Gymnosperms; Structure and Evolution. University of Chicago Press, Chicago.

Coulter, J. M. and Chamberlain, C. J. (1917). Morphology of Gymnosperms. University of Chicago Press, Chicago.

Dutta S.C. (1966). An Introduction to Gymnosperms. Asia Publications House, Mumbai.

Smith, G. M. (1955). Cryptogamic Botany Vol. II. McGraw Hill, New York.

Sporne, K. R. (1974). The Morphology of Gymnosperms. Hutchinson University Library, London.

Chandurkar, P. J. (1983). Plant Anatomy, 4th Ed. Oxford & IBH.

Singh, Pande and Jain. (2009). Anatomy and Embryology of Angiosperms, Rastogi Publication

Tayal, M.S. (2004). Plant Anatomy, Rastogi Publication

Pandey, B. P. (2001). Plant Anatomy, S. Chand and Comp. Ltd.
Esau K. (2006). Anatomy of Seed Plants, 2nd Ed. John Wiley and Sons publication.
Pijush Roy. (2010). Plant Anatomy, New Central Book Agency (P) Ltd.

BO3P1 25: PTERIDOPHYTES, GYMNOSPERMS AND PLANT ANATOMY **Total: 33 Hours (11 Sessions and 3 hrs per week)**	
Sl No.	**LIST OF EXPERIMENTS**
1	Study of morphology, anatomy, and reproductive structures of *Psilotum* and *Lycopodium.*
2	Study of morphology, anatomy, and reproductive structures of *Selaginella* and *Equisetum.*
3	Study of morphology, anatomy, and reproductive structures of *Marsilea.*
4	Study of morphology and anatomy of *Pinus.*
5	Study of reproductive structures of *Pinus* and morphology of *Gnetum.*
6	Study of anatomy and reproductive structures of *Gnetum.*
7	T.S. of dicot and monocot leaf.
8	T.S. of dicot and monocot stem.
9	T.S. of dicot and monocot root.
10	Anomalous secondary growth in *Boerhaavia* and *Dracaena*.
11	Revision/Makeup lab/Attestation of records.

PRACTICAL QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERISTY, BENGALURU – 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
2ND B.Sc., 3rdSEMESTER (CBZ)
BO 3P125: PTERIDOPHYTES, GYMNOSPERMS AND PLANT ANATOMY

MAX. MARKS: 25 **TIME: 2 HOURS 40 MINUTES**

1. Prepare a temporary section of the sample **A**, identify and comment ..... **5x1=5**
2. Prepare a temporary section of the sample **B**, identify and comment..... **5x1=5**
3. Identify and classify the specimens **C** and **D** and comment..... **3x2=6**
4. Identifyand comment on the permanent slide/specimens**E, F**and**G..... 3x3=9**

Key

1. **A:***Equisetum* stem/ *Pinus* needle
2. **B:** Stem/Root/Leaf of Dicot or Monocot
3. **C** and **D:** Specimens fromPteridophyte/ Gymnosperm
4. **E, F** and **G:** Permanent slides from Pteridophyte /Gymnosperm/ Anatomy (Anomalous Sec. growth/ Sec. growth)

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
II B.Sc. BOTANY – III SEMESTER, CBZ
END SEMESTER EXAMINATION
BO 3125: PTERIDOPHYTES, GYMNOSPERMS AND PLANT ANATOMY

Time: 2 Hours **Max Marks: 60**

The paper contains _____printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT

Units	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	03	06
II	09	18
III	03	06
IV	05	10
V	10	18
VI	02	04
VII	06	11
VIII	07	13
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**IV-CBZ**
Paper Code	**BO 4125**
Paper Title	**Palynology and Embryology of Angiosperms (For CBZ)**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practical per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	The main objectives of this course are to: CO1: Introduce students to the foundational concepts of palynology, its history, development, and scope, enabling an understanding of its interdisciplinary applications across various scientific fields. CO2: Explore the morphology of pollen grains, providing students with the ability to identify and classify different pollen types based on their characteristics such as symmetry, shape, size, apertures, and ornamentation. CO3: Investigate the factors affecting pollen viability and storage, equipping students with knowledge on how to assess and preserve pollen for both short-term and long-term usage, contributing to fields like plant breeding and conservation. CO4: Examine the role of palynology in biotechnology, especially in optimizing crop yield, overcoming pollination barriers, and facilitating the production of hybrid seeds, thus enhancing agricultural productivity. CO5: Apply palynology in forensic science, enabling students to understand how pollen analysis aids in criminal investigations and its role in determining geographic origin and environmental context at crime scenes. CO6: Study paleopalynology, linking the study of ancient pollen to understand historical climates, ecosystems, and the role of plant life in past geologic eras, contributing to biostratigraphy and paleoecology. CO7: Introduce students to the embryology of angiosperms,

	covering the development of both male and female reproductive structures, pollination mechanisms, and the unique process of double fertilization in flowering plants. CO8: Analyze the structure and development of embryos in dicots and monocots, exploring endosperm formation, polyembryony, and parthenogenesis, while understanding their applications in plant breeding and agriculture. CO9: Develop practical skills in experimental embryology, focusing on tissue culture techniques, protoplast fusion, and organogenesis, to foster innovation in plant biotechnology and genetic modification.
LEARNING OUTCOMES (LO)	Upon successful completion of this course, students will be able to: LO1: Demonstrate a comprehensive understanding of palynology, including its history, development, key branches, and wide range of applications in fields such as agriculture, forensics, and archaeology. LO2: Identify and classify different types of pollen grains based on their morphology, including their shape, size, symmetry, apertures, and ornamentation, and explain the significance of these features in plant reproduction. LO3: Evaluate pollen viability and vigor, understanding the factors that influence pollen longevity, and apply various techniques for short-term and long-term pollen storage, ensuring effective use in research and agriculture. LO4: Apply palynology in biotechnology, particularly in overcoming pollination constraints, optimizing crop yield, and facilitating hybrid seed production, enhancing students' ability to contribute to agricultural innovation. LO5: Utilize forensic palynology methods to assist in criminal investigations, understanding how pollen evidence can be used to determine the geographic origin of samples and place suspects at specific locations or time periods. LO6: Interpret paleopalynological data, relating ancient pollen records to historical climate changes, past ecosystems, and the study of biostratigraphy, thus contributing to the understanding of

	Earth's past environments. LO7: **Understand the structural and developmental processes in angiosperm embryology**, including the development of microsporangium, megasporangium, and male and female gametophytes, as well as the significance of double fertilization. LO8: **Differentiate between the structure and development of dicot and monocot embryos**, and analyze the formation and function of endosperm, along with understanding polyembryony and its applications in plant breeding. LO9: **Analyze and apply experimental embryology techniques**, such as anther culture, ovary culture, protoplast fusion, and organogenesis, to innovate and solve challenges in plant biotechnology and genetic improvement.

BO 4125: PALYNOLOGY AND EMBRYOLOGY OF ANGIOSPERMS - 45 Hours

Palynology		
UNIT I	**Palynology**: Introduction to Palynology; *History and development of Palynology; Basic branches and their scope (self study).* Applications of palynology.	**1+2**
UNIT II	**Pollen morphology:** Pollen units, polarity, symmetry, shape, size, apertures – NPC classification, apertural types, edges of apertures, views of grains concerning apertures; exine stratification and ornamentation.	**5**
UNIT III	**Pollen Viability and Vigour -** Variations in the longevity of pollen, factors affecting pollen viability. ***Pollen Storage*** *– Short-term and long-term storage and its significance (self study).*	**1+1**
UNIT IV	**Pollen Biotechnology:** Introduction, overcoming pollination constraints for optimization of crop yield; Developing effective pollination control system for commercial production of hybrid seeds; Overcoming crossability barriers to transfer of useful genes to crop species.	**6**
UNIT V	**Forensic Palynology:** Introduction, methodology in forensic study, forensic palynology as an aid in criminology, limitations of forensic palynology. **Paleopalynology:** Definition, history, Biostratigraphy and geochronology; Palaeoecology and climate change; Archaeological palynology.	**2** **2**
Embryology of Angiosperms		
UNIT VI	**Introduction**: Development and structure of Microsporangium - Anther wall, sporogenous tissue. **Microsporogenesis**: Development of male gametophyte. Types of microspore tetrads, pollinia.	**3**
UNIT VII	Structure of megasporangium, Ovule and its types (based on (a) position of chalaza, micropyle and funicle, (b) nucellus, (c) number of integuments); Variations in ovule structure- Aril, integumentary	**3**

	tapetum, caruncle.	

UNIT VIII	**Types of Embryo sac development:** (Monosporic-*Polygonum* type; Bisporic- *Allium* type and Tetrasporic-*Fritillaria* type. Pollination, Self and cross-pollination, their advantages and limitations. Pollen-pistil interaction and self-incompatibility. **Double Fertilization** - Definition, process, importance and uniqueness in angiosperms	**5**
UNIT IX	*Structure of dicot and monocot embryos (Capsella bursa-pastoris, Oryza sativa). Differences between mature Dicot and Monocot embryos (Self study)* **Endosperm**: Development and Function. ***Types of Endosperm:*** *i) Nuclear ii) Cellular iii) Helobial (self study).*	**1+2**
UNIT X	**Polyembryony:** Introduction, Classification of Polyembryony - Simple, Multiple, Nucellar, Integumentary, Endothelial, Zygotic and Suspensor, Synergid - Twins and Triplets; Polyembryony in Hybrids; Causes of Polyembryony; Induction of Polyembryony; Utilization of PluraI Embryos. *Parthenogenesis – Introduction, types and significance (self study).*	**2+1**
UNIT XI	**Experimental Embryology**: Introduction; procedure and nutritional requirements, and applications of anther and pollen Culture; Ovary, Ovule, and Nucellus Culture; Endosperm Culture; Embryo Culture; Protoplast Culture - Embryogenesis and Regeneration, Protoplast Fusion and Somatic Hybridization, "Pomatoes" and "Topatoes" **Organogenesis in Plants**: Transformation of vegetative apex to floral apex, Development of floral organs in *Arabidopsis*. Role of MADS box genes in flower development	**8**

Note: Portions that are underlined are meant for self-study

BO 4P1 25: PALYNOLOGY AND EMBRYOLOGY OF ANGIOSPERMS **Total: 33 Hours (11 Sessions and 3 hrs per week)**		
Sl No.	**LIST OF EXPERIMENTS**	**Sessions**
1	L.S. of flower; T.S of young and mature anther.	
2	Preparation of permanent slides of pollen grains (Erdtman acetolysis method)	
3	Study of Pollen morphology of Monocotyledons – Canna, Commelina, Chloris, Cocos nucifera, Cyperus and determine the shape of the pollen grains	
4	Study of Pollen morphology of Dicotyledons Hibiscus, Mimosa, Acacia, Tridax, Eucalyptus, Pollinia of Calotropis and determine the shape of the pollen grains	
5	Germination of Pollen grains of Catharanthus roseus – Hanging Drop method	
6	Types of placentation and ovules	
7	Mounting of endosperm of Cucumis	

8	Mounting of embryo of Tridax
9	Pollen viability by histo-chemical (acetocarmine) test
10	Pollen viability by TTC test
11	Revision/Makeup lab - Submission to the batch teacher: Preparation of permanent slides in Monocot (1) and Dicot (1) (total 2 slides).

REFERENCES:

1. Agashe, S.N. 2006. Palynology and its application, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Agashe, S.N. and Caulton, E. 2009. Pollen and Spores: Applications with Special Emphasis on Aerobiology and Allergy. CRC Press.
3. Alotaibi, S.A., Sayed, S.M., Alosaimi, M., Alharthi, R., Banjar, A., Abdulqader, N. and Alhamed, R. 2020. Pollen molecular biology: Applications in the forensic palynology and future prospects: A review. Saudi Journal of Biological Sciences 27: 1185-1190.
4. Asif, M. 2013. Parthenogenesis. In: Progress and Opportunities of Doubled Haploid Production. SpringerBriefs in Plant Science, vol 6. Springer, Heidelberg.
5. Bhattacharya, K., Majumdar, M.R. and Bhattacharya, S.W. 2006. A Textbook of Palynology [Basic and Applied]. New Central Book Agency (P) Ltd., London.
6. Bhojwani, S.S., Bhatnagar, S.P. and Dantu, P.K. 2014. An Embryology of Angiosperms (6th Ed.). Vikas Publishing House
7. Birks, H.J.B. and Birks, H.H. 1980. Quaternary Palaeoecology. Arnold. London.
8. Blackmore, S. and Ferguson, I.K. 1986 (eds). Pollen and spores: Form and Function. Academic Press, London.
9. Bryant, V.M. Jr., Mildenhall, D. and Jones, J. 1990. Forensic palynology in the United States of America. Palynology 14:193-208.
10. Dijk, P.V. 2009. Apomixis: Basics for Non-botanists. In: Schön, I., Martens, K. and Dijk, P.V. (eds) Lost Sex: The Evolutionary Biology of Parthenogenesis, Springer.
11. Dutta, A.C. 1997. Botany for Degree Students (6th Ed.), Oxford University Press.
12. Erdtman, G. 1957 "Pollen & spore Morphology / plant taxonomy Vol. 1 - V. Hafner Pub. Co. New York.
13. Faergri, K. and Iversen, J. 1988. Textbook of pollen analysis IV Edit. John Wiley and Sons. New York.
14. Halbritter, H., Ulrich, S., Grímsson, F., Weber, M., Zetter, R., Hesse, M., Buchner, R., Svojtka, M. and Frosch-Radivo, A. 2018. Illustrated Pollen Terminology (2nd Ed), Springer Open.
15. Hojsgaard, D. and Pullaiah, T. 2022. Apomixis in Angiosperms: Mechanisms, Occurrences, and Biotechnology. CRC Press.
16. Johri, B.M. 1984. Embryology of Angiosperms, Springer-Verlag.
17. Johri, B.M. and Srivastava, P.S. 2001. Reproductive Biology of Plants, Springer-Verlag.
18. Maheshwari, P. 1950. An Introduction to Embryology of Angiosperms, McGraw Hill Publication.
19. Mildenhall, D. 2009. Forensic palynology: an increasingly used tool in forensic science. European Journal of Aerobiology and Environmental Medicine, 2: 7-11.
20. Nair, P.K.K. 1970. Pollen Morphology of Angiosperms : a historical and phylogenetic study. Scholar publishing house, Lucknow.
21. Naumova, T.N. 1993. Apomixis in Angiosperms: Nucelar and Integumentary

Embryony. CRC Press.
22. Ogden, E.C. Rayner, G.S. Manual for sampling Airborne Pollen. Hafner Press, Macmillan Publishing Co., Inc, New York.
23. Punt, W., Hoen, P.P., Blackmore, S., Nilsson, S. and Le Thomas, A. 2007. Glossary of pollen and spore terminology. Review of Palaeobotany and Palynology, 143: 1-81.
24. Raghavan, V.R. 2000. Developmental biology of flowering plants. Springer publications.
25. Sandiford, A. 2012. Palynology, pollen, and spores, partners in crime: what, why, and how. In: Hall, D.W. and Byrd, J.H. (eds) Forensic Botany: A Practical Guide, First Edition. John Wiley & Sons, Ltd.
26. Shivanna, K. R. and Tandon, R. 2014. Reproductive Ecology of Flowering Plants: A Manual. Springer.
27. Singh, V., Pande, P.C. and Jain, D.K. 2018. Anatomy and Embryology of Angiosperms, Rastogi Publication.
28. Sinnot E.W. 1960. Plant morphogenesis. Mc Graw Hill Book Company, INC, New York.
29. Stephen, A. 2014. Pollen – A microscopic wonder of plant kingdom. International Journal of Advanced Research in Biological Sciences, 1 (09): 45-62.
30. Traverse, A. 2008. Paleopalynology, 2nd edn. Springer, Dordrecht.
31. Tilak, S.T. 1982 Aerobiology. Vaijayanti Prakashan, Aurangabad.
32. Wardlaw, C.W. 1968. Morphogenesis in Plants. A Contemporary Study. Methuen and Company, London.
33. Wodehouse, R. P. 1935. "Pollen grains" their structure, identification and significance in Science and Medicine. McGraw-Hill, New York.

PRACTICAL EXAMINATION QUESTION PAPER PATTERN

St Joseph's University, Bengaluru - 560027
IV Semester, B.Sc. Botany Practical Examination
BO4P125: Palynology and Embryology of Angiosperms

Time: 3hrs Max. Marks: 25

1. Identify specimens/slides **A, B, C** and comment.	3x3=9 Marks
2. Mount Embryo / Endosperm of **D**, draw neat labeled diagrams and comment.	1x6=6 Marks
3. Perform pollen germination experiment **E** and calculate percentage of germination.	1x6=6 Marks
4. Submission of permanent slides of pollen grains from Monocots (1 slide) and Dicots (1 slide).	2x2=4 Marks

Scheme

- **A.** Pollen slide – 3 marks
- **B.** Types of Placentation – 3 marks
- **C.** TS of Young/Mature anther / Types of Ovules – 3 marks
- **D.** Embryo / endosperm mounting – 6 marks
- **E.** Pollen germination experiment – 6 marks

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
II B.Sc. BOTANY – IV SEMESTER, CBZ
END SEMESTER EXAMINATION
BO 4125: Palynology and Embryology of Angiosperms

Time: 2 Hours **Max Marks: 60**

The paper contains _____printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

D. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

E. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

F. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUE PRINT

Units	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	03	06
II	05	10
III	02	04
IV	06	10
V	04	08
VI	03	06
VII	03	06
VIII	05	10
IX	03	06
X	03	06
XI	08	14
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

ST JOSEPH'S UNIVERSITY

BENGALURU-27

Re-accredited with 'A++' GRADE with 3.79/4 CGPA by NAAC
Recognized by UGC as College of Excellence

BOTANY SYLLABUS

FOR UNDERGRADUATE
PROGRAMME - CBBT

(AS PER SEP 2024-27)

Semester	**I- CBBT**
Paper Code	**BO 1224**
Paper Title	**Virology, Bacteriology, Mycology and Phytopathology**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practicals per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	The course aims to: 1. Evaluate the general structure and classification of viruses based on nucleic acid types. 2. Appreciate the diversity and significance of viruses in biological systems. 3. Describe the ultrastructure of bacterial components, including capsule, flagella, pili, and endospore. 4. Evaluate the economic importance of bacteria in industry, agriculture, and medicine. 5. Identify and describe major plant diseases affecting crops. 6. Appreciate the significance of plant pathology in agriculture and food security.
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to 1. Learn the general structure and classification of viruses based on their nucleic acids (ssDNA, dsDNA, ssRNA, and dsRNA). 2. Understand the role of viruses in disease and biotechnology. 3. Assess the economic importance of bacteria and fungi in industry, agriculture, and medicine. 4. Describe the general characteristics, thallus organization, and nutrition of fungi. 5. Identify the causative agents, symptoms, and control measures for major plant diseases 6. Explain the impact of plant diseases on agriculture and food security.

BO 1224: Virology, Bacteriology, Mycology and Phytopathology

Units	Title of Contents	Hrs (45)
UNIT I	**Virology:** General structure and Baltimore classification. Replication in Viruses: Lytic cycle (T2 phage) and Lysogenic cycle (lambda phage). Structure and multiplication of TMV and CaMV. *Brief account of Viroids and Prions (Self study).*	7+*1*
UNIT II	**Bacteriology:** General account on Archaebacteria and Eubacteria. General characteristics and classification of bacteria based on shape and flagellation. Ultrastructure of Bacteria - Structure of capsule, flagella, pili and endospore. (Ultrastructure of flagella and endospore only), Physical and chemical structure of Gram positive and Gram-negative bacterial cell walls. Reproduction by binary fission. Genetic recombination by conjugation (F+ and F-, Hfr types), Transduction (generalized and specialized types) and Transformation. *Economic importance of Bacteria (Industry, agriculture and Medicine) - (Self study).*	11+*1*
UNIT III	**Mycology:** General characteristics and thallus organization and nutrition in fungi. Reproduction in fungi (asexual and sexual). Type study of; *Pythium*, *Rhizopus*, *Puccinia, Peziza* and *Penicillium*. *Economic importance of fungi (Industry, agriculture and medicine) - (Self study).* **Lichens** – Structure, Classification and reproduction. *Economic importance of lichens - (Self study).*	13+*2*
UNIT IV	**Phytopathology:** *Introduction, brief history and classification based on symptoms - (Self study).* Brief account of the following diseases: Tomato Leaf Curl, Citrus Canker, Sandal Spike, Club Root of Crucifer, Smut of Jowar, Blast of Rice, Red Rot of Sugarcane.	8+*2*

BO 1P224: Virology, Bacteriology, Mycology and Phytopathology

11 Sessions – 3 Hours/ Week

Sl. No.	Experiment	Units/ Sessions
1	Safety measures in microbiology laboratory and study of equipment/appliances used for microbiological studies (Microscopes, Hot air oven, Autoclave/Pressure Cooker, Inoculation needles/loop, Petri plates, Incubator, Laminar flow hood, Colony counter).	1
2	Preparation of culture media (NA/PDA) sterilization, inoculation. Enumeration of soil/water microorganisms by serial dilution technique.	1
3	Gram's staining of bacteria	1
4	Determination of cell count by using Haemocytometer.	1
5	Determination of microbial cell dimension by using Micrometer.	1
6	Study of vegetative structures and reproductive structures – *Stemonitis, Pythium, Rhizopus*	1
7	Study of vegetative structures and reproductive structures- *Puccinia, Penicillium*	1
8	Study of vegetative structures and reproductive structures- *Trichoderma* and Peziza	1
9	Study of Tomato Leaf Curl, Citrus Canker, Sandal Spike, Club Root o f Crucifer.	1
10	Study of Smut of Jowar, Blast of Rice, Red Rot of Sugarcane and Tikka disease of Groundnut.	1
11	Revision.	1

References

1. Ananthnarayan R and Panikar JCK. 1986. Text book of Microbiology. Orient Longman ltd. New Delhi.
2. Arora DR. 2004. Textbook of Microbiology, CBS, New Delhi.
3. William CG. 1989. Understanding microbes. A laboratory text book for Microbiology. W.H.
4. Freeman and Company. New York.
5. Dubey RC and Maheshwari DK. 2007. A textbook of Microbiology, S. Chand and Company, New Delhi.
6. Dubey RC and Maheshwari DK. 2002. A Text book of Microbiology, S.C. Chand and Company, Ltd. Ramnagar, New Delhi.
7. Sharma R. 2006. Text book of Microbiology. Mittal Publications. New Delhi. 305pp.

8. Sharma PD. 1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
9. Vasanthkumari R. 2007. A textbook of Microbiology, BI Publications Pvt. Ltd., New Delhi.
10. Alexepoulos CJ and Mims CW. 1989. Introductory Mycology, Wiley Eastern Ltd., New Delhi.
11. Allas RM. 1988. Microbiology: Fundamentals and Applications, Macmillan publishing co. New York.
12. Brook TD, Smith DW and Madigan MT. 1984. Biology of Microorganisms, 4th ed. Eaglewood Cliffts. N.J. Prentice-Hall. New Delhi.
13. Burnell JH and Trinci APJ. 1979. Fungal walls and hyphal growth, Cambridge University Press. Cambridge.
14. Jayaraman J. 1985. Laboratory Manual of Biochemistry, Wiley Eastern Limited. New Delhi.
15. Ketchum PA. 1988. Microbiology, concepts and applications. John Wiley and Sons. New York.
16. Michel J, Pelczar Jr.EC and Krieg CR. 2005. Microbiology, Mc.Graw-Hill, New Delhi.
17. Powar CB and Daginawala. 1991. General Microbiology, Vol – I and Vol – II Himalaya
publishing house, Bombay.
18. Reddy S and Ram. 2007. Microbial Physiology. Scientific Publishers, Jodhpur, 385pp.
19. Sullia SB and Shantharam S. 1998. General Microbiology. Oxford and IBH publishing Co. Pvt. Ltd. New Delhi.
20. Schlegel HG. 1986. General Microbiology. Cambridge. University Press. London, 587pp.
21. Roger S, Ingrahan Y, Wheelis JL, Mark L and Page PR. 1990. Microbial World 5th edition.
Prentice-Hall India, Pvt. Ltd. New Delhi.
22. Sullia SB. and Shantharam S. 2005. General Microbiology, Oxford and IBH, New Delhi.

ST. JOSEPH'S UNIVERSITY, BENGALURU - 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
I B.Sc. I SEMESTER - CBBT
BO1P224 – VIROLOGY, BACTERIOLOGY, MYCOLOGY AND PHYTOPATHOLOGY
BOTANY PRACTICAL EXAMINATION

MAX. MARKS: 25 **TIME: 3 HOURS**

I	Perform the Gram's staining for **A.** Write the principle, identify with reasons and leave the preparation for evaluation	2+2=4
II	Calculate the population of yeast cells using haemocytometer/ measure cell dimensions using micrometer in the given sample **B**. Briefly describe the instrument and tabulate the result.	2+2=4
III	Identify and classify the specimens **C** and **D** with reasons.	2X2.5=5
IV	Identify the slides **E** and **F** with labeled diagrams and reasons.	2X3=6
V	Comment on spotters **G, H** and **I**	2X3=6

KEY

A – Curd sample/Root nodule extract

B – Haemocytometry - Yeast cells. Micrometry - Pollen or Epidermal cells or Fungal spores

C & D – Fungal specimens

E & F – Fungal slides

G, H and I – Plant pathology specimen/ slide, Microbiological instrument, Serial dilution/ Culture plate

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
I B.Sc. BOTANY – I SEMESTER, CBBT
SEMESTER EXAMINATION
BO 1224: VIROLOGY, BACTERIOLOGY, MYCOLOGY AND PHYTOPATHOLOGY

Time: 2 Hours **Max Marks: 60**

The paper contains TWO printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	08	16
II	12	22
III	15	28
IV	10	20
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**II – CBBT**
Paper Code	**BO 2224**
Paper Title	**Applied Phycology and Bryology**
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of theory credits	03
Total number of teaching hours of practicals per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	The course aims to 1. Analyze the diversity, habitat, thallus organization, and reproductive strategies of algae, including a classification of algae up to the class level. 2. Understand and describe the morphology, anatomy, and reproductive processes of a species 3. Assess the economic and ecological importance of algae and bryophytes, focusing on their applications in biofertilizers, biodiesel production, and water quality indicators. 4. Investigate the evolutionary relationships between algae and bryophytes, emphasizing their phylogenetic connections and ecological roles. 5. Explore the impact of pollution on bryophytes, their stress tolerance mechanisms, and conservation strategies for algae and bryophytes in a changing environment.
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to 1. Identify and explain the key features of algae, including their diversity, reproductive types, and classification systems. 2. Examine and describe the systematic position, structure, and reproductive methods of various algae species such as Anabaena, Volvox, and Sargassum. 3. Demonstrate an understanding of the life cycle, morphological

	characteristics, and classification of bryophytes, with specific focus on Proskauer's system. 4. Understand the methods of algal biodiesel production and the applications of algae as biofertilizers, and compare their benefits with traditional agricultural practices. 5. Investigate the bioactive compounds derived from bryophytes, including their pharmacological properties such as antimicrobial and antioxidant activities, and explore their potential applications in the cosmetic industry.

BO2224 – Applied Phycology and Bryology

Units	Title of Contents	Hours (45)
UNIT I	**Algae – General concepts** Diversity of Algae with respect to habitat, thallus organization and reproduction. *Classification of algae (upto classes) by Fritsch (self study).*	**5 + *2***
UNIT II	**Algae – Type study** Systematic position, structure and reproduction of the following forms: *Anabaena, Volvox, Spirogyra, Vaucheria, Sargassum, Batrachospermum*.	**7**
UNIT III	**Bryophytes – General concepts** Bryophytes: Distribution, general characters, alternation of generation and classification of Bryophytes by Proskauer (1957).	**4**
UNIT IV	**Bryophytes – Type study** Morphology, anatomy and reproduction of *Marchantia, Anthoceros and Sphagnum* (developmental details not required).	**6**
UNIT V	Origin and phylogenetic relationships between algae and bryophytes.	**3**
UNIT VI	Algal immobilization and its applications, Blue-green algal bio-fertilizer: Method of preparation (Trough/ Tank method, Pit method). Applications and advantages of biofertilizers over inorganic fertilizers	**3**
UNIT VII	Fuels- Renewable and Non – renewable. Algal biodiesel; Cultivation and extraction methods. *Advantages over other sources of biodiesel (Self study)*	**2 + *1***
UNIT VIII	*Algae as water quality indicators; Algal blooms-causes and effects (Self study)*	***2***
UNIT IX	Bioactive compounds from bryophytes: phytochemicals from bryophytes and their bioactivity. Pharmacological activity of bryophytes - antimicrobial activity, antifungal activity, cytotoxic activity, antioxidant activity *Bioactive ingredients from Bryophytes for the cosmetic industry (self study).*	**3 + *1***
UNIT X	Bryophytes in a changing world – impact of pollution on bryophytes, application to bioindication, adaptation to a changing environment. Stress tolerance in bryophytes. Conservation biology for algae and bryophytes – threats, need for conservation and conservation strategies. Role of peat in soil less plant growth.	**6**

BO 2P224: Applied Phycology and Bryology

11 Sessions – 3 Hours/ Week

Sl. No.	Experiment	Units/ Sessions
1	Type study of *Anabaena, Scytonema, Volvox*	1
2	Type study of *Spirogyra, Chara, Vaucheria*	1
3	Type study of *Sargassum, Batrachospermum*	1
4	Type study of *Marchantia*	2
5	Type study of *Anthoceros*	1
6	Type study of *Funaria*	1
7	Isolation of algae from water samples by serial dilution method	1
8	Demonstration of algal culture using Chu10 medium	1
9	Extraction and separation of photosynthetic pigments from an algal sample	1
10	Institutional visit to study culturing of microalgae	1

References:

1. Fritsch, FE. 1961. Structure and reproduction in algae,Vol.I and II, camridge UniversityPress, London
2. Trivedi, PC. 2001. Algal biotechnology, Pointer publishers, Jaipur, India.
3. Bold and Wynee, 1985. Introduction to Algae- structure and reproduction; Prentice hall,India.
4. Vashishta, BR. 1976. Botany for degree students Part 1.Algae,S.Chand and company, New Delhi.
5. Parihar, NS.1962. Bryophyta, Central book depot, Allahabad.
6. Srivastava, HN. 1993. Bryophyta, Pradeep Publications, Allahabad.
7. Watson, EV. 1971. The structure and life of Bryophytes, Hutchinson and Co., London.
8. Goffinet, B. and Shaw, J. 2009. Bryophyte biology. Cambridge University press, London.
9. Das, K. Kityania, S. Nath, R. Das, S. Nath, D. and Talukdar, AD. 2022. Bioactive Compounds from Bryophytes. In: H. N. Murthy (ed.), Bioactive Compounds in Bryophytes and Pteridophytes. Springer Nature Switzerland.
10. Henes, B. Zu¨ lli, F. Niederkru¨ ger, H. Schaaf, A. Frischmuth, T. Decker, EL. Reski, R. The magic of moss. Soap Perfumery Cosmet 2018, 91:64-66.
11. Wandrey F, Henes B, Zu¨ lli F, Reski J: Biotechnologically produced moss active improvesskin resilience. SOFW J 2018, 144:34-37.
12. Decker, E. L. and Reski, R. 2020. Mosses in biotechnology. Current Opinion inBiotechnology, 61:21–27.

13. Horn, A. Pascal, A. Lončarević, I. Volpatto Marques, R. Lu, Y. Miguel, S.… Simonsen, HT. 2021. Natural Products from Bryophytes: From Basic Biology to Biotechnological Applications. Critical Reviews in Plant Sciences, 40(3), 191–217.
14. Martínez-Abaigar, J. and Núñez-Olivera, E. 2021. Novel biotechnological substances frombryophytes. In: R. P. Sinha, D-P. Häder (Eds). Natural Bioactive Compounds, Academic Press, 233-248.

ST. JOSEPH'S UNIVERSITY, BENGALURU - 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
I B.Sc. II SEMESTER - CBZ
BO2P224 – APPLIED PHYCOLOGY AND BRYOLOGY BOTANY PRACTICAL EXAMINATION

MAX. MARKS: 25 TIME: 3 HOURS

I	Identify specimens A and B with classification and reasons	2 × 3 = 6
II	Prepare a temporary slide of C, identify, comment and leave the preparation for evaluation	5
III	Separate the photosynthetic pigments from the given algal sample D and calculate the Rf values. Write the principle and discuss the results.	5
III	Identify the slides E, F and G with labeled diagrams and reasons	3 × 3 = 9

KEY

A and B– Algae and Bryophyte specimens

C – Algae specimen

D – Algae sample

E, F, G – Algae and Bryophyte slides

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027

I B.Sc. BOTANY – II SEMESTER, CBBT

SEMESTER EXAMINATION

BO 2224: APPLIED PHYCOLOGY AND BRYOLOGY

Time: 2 Hours **Max Marks: 60**

The paper contains TWO printed pages and THREE parts

Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Answer ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hours	Total marks for which the questions are to be asked (including bonus questions)
I	7	13
II	7	13
III	4	8
IV	6	11
V	3	6
VI	3	6
VII	3	6
VIII	2	4
IX	4	8
X	6	11
TOTAL	45	86
Note: Maximum marks for the paper (Excluding bonus question): 60		

Semester	**III**
Paper Code	**BO 3225**
Paper Title	**Plant Anatomy, Paleobotany and Palynology (CBBT)**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practical per semester	33
Number of practical credits	02

COURSE OBJECTIVES **(CO)**	This course aims to 1. To gain a comprehensive understanding of the structure and function of plant cells, tissues, and organs, focusing on ultrastructural organization of plant cell walls, meristems, and vascular tissues. 2. To understand the organization and functional significance of apical and lateral meristems, the theories of shoot and root apical meristem organization, and the role of secondary growth in plants. 3. To study specialized plant structures to gain insight into their roles in protection, transport, and environmental interaction. 4. To acquire knowledge in the identification, preservation, and analysis of plant fossils and pollen, including modern techniques for studying ancient plant life, their economic importance, and their relevance in understanding past climates and ecosystems.
LEARNING OUTCOMES **(LO)**	After completion of the course - 1. Students will be able to explain the structural organization of plant cells, tissues, organs and specialized structures like stomata and secretory cells. 2. Students will be able to describe the theories of shoot and root apical meristem organization and understand how secondary growth occurs in plants, including anomalous growth. 3. Students will gain the ability to classify various types of plant fossils and explain the fossilization process. They will also be proficient in different fossil preparation techniques, such as thin sectioning, maceration, and X-ray imaging, and understand their significance in reconstructing plant evolution and paleoecology. 4. Students will acquire knowledge of pollen grain morphology, including aperture patterns and exine ornamentation, and will be able to identify and classify pollen using the NPC system. They will also understand the applications of palynology.

BO 3225: PLANT ANATOMY, PALEOBOTANY AND PALYNOLOGY - 45 Hours		
	PLANT ANATOMY	**25 hours**
UNIT I	Introduction and scope of plant anatomy. **Plant cell**: Ultra-structural organization - primary and secondary wall layers of plant cell wall and its functions.	3
UNIT II	*Meristems and its types.* Structural organization of Shoot Apical Meristem (SAM) - Theory of organization (Tunica-Corpus). Organization of Root apical meristem (Korper-Kappe theory) and quiescent center concept.	2+*2*
UNIT III	Simple and complex permanent tissues. Anatomy of dicot and monocot leaf, *stem and root.* Types of vascular bundles. Secondary growth of dicot stem (*Helianthus*) and dicot root (*Cicer*); Anomalous secondary growth in the stem of *Boerhaavia* and *Dracaena*.	6 + *2*
UNIT IV	**Wood:** Ray and axial parenchyma; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. **Periderm:** Development and composition of periderm, rhytidome and lenticels	6
UNIT V	**Variations of adaptive and protective systems:** epidermis, cuticle, epicuticular waxes and stomata. **Secretory structures in plants:** External secretory structures: Glandular trichomes, colleters, stinging hair, nectaries, hydathodes, salt glands, oil cavities, resin ducts and laticifers. Internal secretory structures: Idioblasts and cystoliths	4

	PALEOBOTANY	9 hours
UNIT VI	Introduction to Paleobotany **General account on plant fossils and its** types - impressions, compressions, petrification, nodules, moulds, casts coal balls, compactions and ambers. **Techniques to study fossils:** ground thin section technique, peel technique, transfer technique, maceration technique, X-ray technique, microtomy technique. Determination of the age of fossils by carbon dating and radioisotope dating. *Economic importance of fossils.*	8+*1*
	PALYNOLOGY	**11 hours**
UNIT VII	Introduction, scope and branches of palynology - brief concept of Mellissopalynology. Morphology of pollen grain: pollen wall structure, polarity, symmetry, size and shape, apertural pattern, exine stratification and ornamentation of pollen wall. NPC system of classification. Pollen bank. *Methods in palynology: Acetoylsis technique.* **Forensic palynology:** introduction, spores and pollens, abundance, dispersal, sample collection, identification of pollen, preservation, non-palynological remains associated with samples and applications. **Palaeopalynology:** introduction, palaeopalynology in geochronology, biostratigraphy and paleoecology. Distribution, abundance and durability of palynomorphs, disadvantages and limitations.	10+*1*

NOTE: Portions that are underlined are meant for self-study

References

Sporne, K.R. (1970). The Morphology of Pteridophytes: The Structure of Ferns and allied Plants. Hutchinson Co., London.

Sundara Rajan, S. (2009). Introduction To Pteridophyta. New Age International Publisher. New Delhi.

Rashid, A. (1999). An Introduction to Pteridophyta, 2/e. Vikas Publishing.

Sharma O. P. (2023). Textbook of Pteridophyta. Medtech Science Press; 2nd edition, New Delhi.

Parihar, N. S. (1977). The Biology and Morphology of the Pteridophytes. Central Book Depot, Allahabad.

Eames, A. J. (1936). Morphology of Vascular Plants-Lower Groups (Psilophytales to Filicales), McGraw Hill, New York.

Bhatnagar, S. P. and Alok Mitra. (1966). Gymnosperms. New Age International (P) Ltd.

Publishers.
Chamberlain, C. J. (1935). Gymnosperms; Structure and Evolution. University of Chicago Press, Chicago.
Coulter, J. M. and Chamberlain, C. J. (1917). Morphology of Gymnosperms. University of Chicago Press, Chicago.
Dutta S.C. (1966). An Introduction to Gymnosperms. Asia Publications House, Mumbai.
Smith, G. M. (1955). Cryptogamic Botany Vol. II. McGraw Hill, New York.
Sporne, K. R. (1974). The Morphology of Gymnosperms. Hutchinson University Library, London.
Chandurkar, P. J. (1983). Plant Anatomy, 4th Ed. Oxford & IBH.
Singh, Pande and Jain. (2009). Anatomy and Embryology of Angiosperms, Rastogi Publication
Tayal, M.S. (2004). Plant Anatomy, Rastogi Publication
Pandey, B. P. (2001). Plant Anatomy, S. Chand and Comp. Ltd.
Esau K. (2006). Anatomy of Seed Plants, 2nd Ed. John Wiley and Sons publication.
Pijush Roy. (2010). Plant Anatomy, New Central Book Agency (P) Ltd.
Richard Crang, Sheila Lyons-Sobaski, Robert Wise. (2018). A Concept-Based Approach to the Structure of Seed Plants. Springer Nature Switzerland AG. 725. https://doi.org/10.1007/978-3-319-77315-5.
Editorial. (2006). Forensic palynology: Why do it and how it works. *Forensic Science International* Elsevier, 163, 161–162. doi:10.1016/j.forsciint.2006.07.012.
Traverse, A. (2007). Why One ‘‘Does’’ Paleopalynology and Why It Works. In: Paleopalynology. Topics in Geobiology, vol 28. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-5610-9_2.

BO 3P225: Plant Anatomy, Paleobotany and Palynology (CBBT) Total: 33 Hours (11 Sessions and 3 hours per week)		
Sl No.	**LIST OF EXPERIMENTS**	**Sessions**
1	Anatomy of dicot and monocot leaf.	1
2	Anatomy of dicot and monocot stem.	1
3	Anatomy of dicot and monocot root.	1
4	Study of secretory systems in plants: glandular, non-glandular trichomes and colleters.	1
5	Adaptive anatomy of *Nerium* and *Hydrilla.*	1
6	Anatomy of anomalous secondary growth in *Boerhaavia* and *Dracaena*.	1
7	Study of permanent slides – xylary elements.	1
8	Study of types of fossil specimens.	1
9	Study of pollen grain morphology.	1
10	Semi-permanent slide preparation of pollen grains using Wodehouse technique.	1
11	Revision/Makeup lab/Attestation of records.	1

PRACTICAL QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERISTY, BENGALURU – 560 027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
2nd B.Sc., 3rd SEMESTER (CBBT)
BO 3P225: PLANT ANATOMY, PALEOBOTANY AND PALYNOLOGY

MAX. MARKS: 25 **TIME: 2 HOURS 40 MINUTES**

1. Prepare a temporary section of sample **A**, identify and comment ..... **5x1=5**
2. Mount semi-permanent slides of sample **B and C**, identify and comment ..... **4x2=8**
3. Identify the permanent slide **D** and comment..... **4x1=4**
4. Identify and comment on the permanent slide/specimens **E** and **F** ..... **4x2=8**

Scheme

1. **A:** Stem/Root/Leaf of Dicot or Monocot
2. **B** and **C:** Any 2 types of pollen
3. **D:** Xylary elements/ Anomalous secondary growth
4. **E** and **F:** Fossil specimens/ Secretory structures

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
II B.Sc. BOTANY – III SEMESTER, CBBT
SEMESTER EXAMINATION
BO 3225: PLANT ANATOMY, PALEOBOTANY AND PALYNOLOGY

Time: 2 Hours **Max Marks: 60**

The paper contains TWO printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	03	6
II	04	8
III	08	15
IV	06	11
V	04	8
VI	09	17
VII	11	21
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**IV - CBBT**
Paper Code	**BO 4225**
Paper Title	**Pteridophytes and Gymnosperms**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practicals per semester	33
Number of practical credits	02

COURSE OBJECTIVES **(CO)**	The course aims to: 1. Provide a basic understanding of Pteridophytes and Gymnosperms, including their characteristics, distribution, and affinities. 2. Explain the sporophyte and gametophyte stages, reproductive mechanisms, and life cycles of selected forms. 3. Analyze stelar variations in Pteridophytes and understand the seed habit phenomenon. 4. Explore fossil records, geological time scales, and the evolutionary significance of ancient Pteridophytes and Gymnosperms. 5. Understand these plant groups' bioprospecting opportunities, ecological roles, and economic uses. 6. Familiarize students with preserved and live specimens, enabling hands-on experience in identifying and studying selected species.
LEARNING OUTCOMES **(LO)**	After completion of the course, the students will - 1. Learn about the characteristics, distribution, and relationships of Pteridophytes and Gymnosperms. 2. Study the sporophyte and gametophyte stages, along with reproductive strategies. 3. Differentiate stelar types and understand the evolution of seed habit in Pteridophytes. 4. Learn about the geological time scale and fossil records related to these plant groups. 5. Explore Pteridophytes and Gymnosperms' economic and medicinal importance. 6. Gain hands-on experience with preserved and live specimens of selected species.

BO4225: PTERIDOPHYTES AND GYMNOSPERMS		
UNIT NO.	**CONTENT**	**45 HOURS**
	Pteridophytes	
Unit I	A general account of characteristic features, distribution, and affinities of Pteridophytes with Gymnosperms. Classification (Smith, 1955).	04+01
Unit II	Systematic position, sporophytic structure, anatomy, reproduction, and life cycle of *Psilotum, Lycopodium, Selaginella, Equisetum, and Marsilea.* Study of fossil Pteridophyte – *Rhynia, Lepidodendron* and *Calamites.*	15
Unit III	A brief account of seed. Heterospory and seed habit. A brief account of stele. Stelar evolution in Pteridophytes.	05+02
Unit IV	Bioactive Compounds of Pteridophytes; Anticancer Properties of Pteridophytes and Derived Compounds; Pteridophytes as Ecological Indicators. A brief account of *Azolla* cultivation.	02+01
	Gymnosperms	
Unit V	A general account of characteristics, distribution, and affinities of Gymnosperms with Angiosperms. Classification (Sporne, 1965). Salient features of Cycadales, Coniferales, and Gnetales.	04+01
Unit VI	Systematic position, sporophytic structure, anatomy, reproduction, and life cycle of *Pinus* and *Gnetum*. Bioactive Compounds of Gymnosperms Economic importance of Gymnosperms.	09+01

NOTE: Portions that are underlined are meant for self-study

BO4P225: PTERIDOPHYTES AND GYMNOSPERMS Total: 33 Hours (11 Sessions and 3 hrs. per week)	
LIST OF EXPERIMENTS	
Practical 1:	Study of morphology, anatomy, and reproductive structures of *Psilotum.*
Practical 2:	Study of morphology, anatomy, and reproductive structures of *Lycopodium.*
Practical 3:	Study of morphology, anatomy, and reproductive structures of *Selaginella.*
Practical 4:	Study of morphology, anatomy, and reproductive structures of *Equisetum.* Temporary slide preparation of *Equisetum* stem.
Practical 5:	Study of morphology, anatomy, and reproductive structures of *Marsilea.*
Practical 6:	Study of morphology and anatomy in *Pinus.* Temporary slide preparation of *Pinus* needle.

Practical 7:	Study of reproduction in *Pinus* and morphology of *Gnetum.*
Practical 8:	Study of anatomy and reproductive structures of *Gnetum.*
Practical 9:	Demonstration of *Azolla* cultivation.
Practical 10:	Study of fossil genera: *Rhynia, Glossopteris,* and *Pentoxylon.*
Practical 11:	Revision/Makeup lab/Attestation of records.

REFERENCES

Sporne, K.R. (1970). The Morphology of Pteridophytes: The Structure of Ferns and allied Plants. Hutchinson Co., London.

Agashe, S. N. (1995). Paleobotany. Oxford & IBH Publishing Company. New Delhi.

Andrews, H. N. (1961). Studies in Paleobotany. John Wiley & Sons, New York.

Bhatnagar, S. P. and Alok Moitra. (1966). Gymnosperms. New Age International (P) Ltd. Publishers.

Chamberlain, C. J. (1935). Gymnosperms; Structure and Evolution. University of Chicago Press, Chicago.

Coulter, J. M. and Chamberlain, C. J. (1917). Morphology of Gymnosperms. University of Chicago Press, Chicago.

Dutta S.C. (1966). An Introduction to Gymnosperms. Asia Publications House, Mumbai.

Eames, A. J. (1936). Morphology of Vascular Plants-Lower Groups (Psilophytales to Filicales), McGraw Hill, New York.

Mildawati, Azka, S. A., Azirda, M. F., and Solfiyeni. (2024). Diversity and bioprospecting of pteridophyte in the Indigenous Talang Mamak Tribe, Riau, Indonesia. *SABRAO Journal of Breeding and Genetics,* 56(5): 1845-1857.

Murthy, H. N. (Ed.) (2023). Bioactive Compounds in Bryophytes and Pteridophytes. Springer.

Parihar, N. S. (1977). The Biology and Morphology of the Pteridophytes. Central Book Depot, Allahabad.

Rashid, A. (1999). An Introduction to Pteridophyta, 2/e. Vikas Publishing.

Sharma O. P. (2023). Textbook of Pteridophyta. Medtech Science Press; 2nd edition, New Delhi.

Smith, G. M. (1955). Cryptogamic Botany Vol. II. McGraw Hill, New York.

Sporne, K. R. (1965). The Morphology of Gymnosperms. Hutchinson University Library, London.

Sporne, K. R. (1970). The Morphology of Pteridophytes: The Structure of Ferns and Allied Plants. Hutchinson Co., London.

Sundara Rajan, S. (2009). Introduction To Pteridophyta. New Age International Publisher. New Delhi.

PRACTICAL EXAMINATION QUESTION PAPER PATTERN

St Joseph's University, Bengaluru - 560027
III Semester, B.Sc. Botany Practical Examination
BO4P225: Pteridophytes and Gymnosperms

Time: 3hrs Max. Marks: 25

1. Identify specimens **A, B, C** and comment.	3x3=9 Marks
2. Identify slides **D, E,** and **F,** Classify, draw neat labeled diagrams and comment.	3x3=9 Marks
3. Prepare a temporary slide of **G.** Comment with a neat labeled diagram and leave the preparation for evaluation.	1x5=5 Marks
4. Submission of one Pteridophyte/Gymnosperm specimen	2 Marks

Scheme

A. Pteridophytes – 3 marks
B. Pteridophytes – 3 marks
C. Gymnosperms – 3 marks
D. Pteridophyte – 3 marks
E. Fossils; Pterophytes/Gymnosperms – 3 marks
F. Gymnosperms – 3 marks
G. Gymnosperms/Pteridophytes – 5 marks
Submission – 2 marks

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
II B.Sc. BOTANY – III SEMESTER, CBBT
SEMESTER EXAMINATION
BO 4225: PTERIDOPHYTES AND GYMNOSPERMS

Time: 2 Hours **Max Marks: 60**

The paper contains TWO printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

D. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.

3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

E. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

F. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	03	06
II	16	30
III	09	18
IV	02	04
V	05	10
VI	10	18
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**V**
Paper Code	**BO5126**
Paper Title	**Plant Physiology and Biochemistry**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practical per semester	33
Number of practical credits	02

COURSE OUTCOMES (CO)	This course aims to: 1. Provide an understanding of water and nutrient transport in plants, including mechanisms like transpiration and phloem loading. 2. Introduce the structure and function of the photosynthetic and respiratory systems in plants. 3. Explain the physiological processes regulating plant growth, development, and flowering. 4. Explore the biochemical and structural basis of plant defense and immunity. 5. Highlight the significance of plant-microbe interactions in enhancing plant productivity and health
LEARNING OUTCOMES (LO)	After completion of this course, students will be able to 1. Analyze the mechanisms involved in plant-water relations and nutrient transport. 2. Explain the major biochemical pathways of photosynthesis and respiration in plants. 3. Assess the role of hormones in regulating plant growth, development, and movement. 4. Describe various plant defense strategies and the role of secondary metabolites in immunity.

	5. Evaluate the contribution of beneficial microbes to plant nutrition and disease resistance.

BO5126: PLANT PHYSIOLOGY AND BIOCHEMISTRY

Units	Title of Contents	45 Hrs
UNIT I	**Plant water relations** Plant - water relations - Diffusion, osmosis, imbibition, water potential and its components. Absorption of water: The mechanism of water absorption - active and passive (in brief). Transpiration in plants – Concept, Structure of monocot and dicot stomata, Mechanism of opening and closing of stomata – K+ ion pump theory. Ascent of sap – Transpiration pull theory. Anti-transpirants and its types.	**5**
	Phloem transport Source and sink concept, vein loading and unloading; transport mechanism (protoplasmic streaming hypothesis, Mass flow hypothesis). *Factors affecting phloem transport (Self study).*	**2 + *1***
	Mineral nutrition Deficiency symptoms of macronutrients and micronutrients in plants. Environmental factors which special reference to soil factors affecting nutrient availability and uptake. Ion antagonism.	**2**
UNIT II	**Photosynthesis** Structure of chloroplast and ultrastructure of thylakoid membrane, concept of quantosomes. Parts of a photosystem. Difference between Photosystems I and II. *Principles of light absorption (Self study).* Photosynthetic electron transfer and photophosphorylation, mechanism of ATP synthesis (Chemiosmotic hypothesis). Mechanisms of carbon fixation and carbohydrate synthesis - C3 cycle, C4 pathway, CAM pathway and significance. Photorespiration: Mechanism, organelles involved and significance.	**8 + *1***
UNIT III	**Respiration** Glycolysis, TCA cycle, ETS and Oxidative phosphorylation. Brief account of anaerobic respiration (alcohol and lactic acid fermentation), *Respiratory quotient and its significance (Self-study)*	**5 + *1***
UNIT IV	**Flowering in plants** Photoperiodism: Types of plants based on photoperiod – Long day plants, short day plants, day neutral plants.	**5+*1***
	Role of phytochromes in flowering, *Vernalization (Self-study.)* ABCDE Model of development of flower.	

UNIT V	**Plant growth and plant movements** Physiological roles and horticultural applications of Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene. Role of jasmonic acid in brief. *(Any two hormones self-study).* Plant movements – Tropic & Nastic movements & their types	**5 +*2***
UNIT VI	**Plant stress physiology** Plant stress – definition, types (biotic and abiotic). General overview of biotic (infection and herbivory) and abiotic stress (drought, salinity, temperature stress). Brief account of - Innate and induced plant defenses, structural and biochemical defenses (role of secondary metabolites).	**4**
UNIT VII	**Plant microbe interaction** Symbiotic nitrogen fixation in legumes by *Rhizobium* – Mechanism of nodulation and nitrogen fixation. Role of Nitrogenase. A brief introduction to endophytes (fungal and bacterial). Role of endophytes in enhancing plant growth and defense responses	**3**
Note: Portions that are underlined are meant for self-study		

BO5P126: PLANT PHYSIOLOGY AND BIOCHEMISTRY

11 Sessions – 3 hours/ Week

Sl. No.	Experiments	Units/ Sessions
1	Observation of plasmolysis and determination of osmotic potential by plasmolytic method.	1
2	Study of stomatal types and determination of Stomatal Index in monocot and dicot leaves.	1
3	Study of the effect of temperature and salinity on membrane permeability using spectrophotometer	1
4	Studying of mineral deficiencies in plants through hydroponics	1
5	Estimation of fructose in different fruits by resorcinol method.	1
6	Separation of photosynthetic pigments by paper chromatography and finding their Rf values.	1
7	Estimation of total chlorophyll by spectrophotometer method.	1
8	Qualitative estimation of secondary metabolites (phenols, flavonoids, alkaloids, Tannins, terpenoids, saponins, glycosides)	1
9	Instruments as spotters (Clinostat, Phototropic chamber, Set-up for hydrotropism, Ganong's respirometer, Suction force by thistle funnel)	1
10	Effect of Gibberellins on Bolting	1
11	Revision	1

References

1. Srivastava, H. N, (2007). Plant Physiology, Rastogi Publications
2. Mukherji, S. and Gupta A. K. (2005). Plant physiology. New Central Book Agency, New Delhi.
3. Salisbury F.B. and Ross C.W. 1986. Plant Physiology. CBS Pub. New Delhi.
4. Dey, P.M., and Harborne, J.N., 1977. Plant Biochemistry, Academic Press, New York
5. Hall, D.O & Rao, K.K., 1999. Photosynthesis 6th ed., Published in association with the Institute of Biology, Cambridge University Press.
6. Moore, T.C., 1989. Biochemistry and Physiology of Plant hormones, Narosa Pub. House, New Delhi.
7. Singh, B.N. & Mengel, K., 1995. Plant physiology and biochemistry, Panima Pub. Corporation, New Delhi.
8. Singal, G.S., Genger, G.C., Sopory, S.K., Irrgang, K.D. & Govindjee, 1999. Concepts in photobiology, photosynthesis and photomorphogenesis, Narosa Pub. House, New Delhi.
9. Meyer B.S. and Anderson D.B., 2017, Plant Physiology, Agri-biovet Press, New Delhi.
10. L.Taiz and E.Zeiger, I.M.Moller and A. Murphy, 2015, Plant Physiology 6th Ed., Sinauer Associates, Inc, USA.
11. W.G.Hopkins and N.P.A.Huner, 2009, Introduction of plant physiology, 4th Edition, John Wiley and Sons, Inc.
12. Stumpf, PK, and Conn, EE (eds.) 1988. The Biochemistry of Plants - A comprehensive treatise, Academic Press, New York.
13. Wilkins, M.B.(Ed.)1989. Advanced plant physiology. Pitman publishing Ltd., London.

PRACTICAL QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERISTY, BENGALURU – 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
III B.Sc. V SEMESTER
BO5P126 – PLANT PHYSIOLOGY AND BIOCHEMISTRY
BOTANY PRACTICAL EXAMINATION

MAX MARKS – 25 **TIME – 2 HOURS 40 MINUTES**

I	Separate the photosynthetic pigment mixture **A** by paper chromatography and calculate the Rf for each constituent	6
II	Conduct the experiment **B** and write a note on the requirements, principle and calculations. Report your result and discuss the same	6
III	Conduct the experiment **C** and write a note on the requirements, principle and calculations. Report your result and discuss the same	6
III	Identify the spotters **D**, write your comments.	4
IV	Answer the questions **E** and **F**	2 × 1.5=3

KEY

A – Photosynthetic pigment mixture

B - Observation of plasmolysis and determination of osmotic potential by plasmolytic method.

Or

Study of stomatal types and determination of Stomatal Index in monocot and dicot leaves.

Or

Study of the effect of temperature on membrane permeability using spectrophotometer

C - Estimation of total chlorophyll by spectrophotometer method.

Or

Qualitative estimation of secondary metabolites

Or

Estimation of fructose in different fruits by resorcinol method.

D - Spotters

E & F – Questions of hydroponics and mineral nutrition or any other experiment from the syllabus

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU – 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
III B.Sc. V SEMESTER
BO5126 – PLANT PHYSIOLOGY AND BIOCHEMISTRY
BOTANY PRACTICAL EXAMINATION

TIME:2 HOURS **MAX. MARKS : 60**

The paper contains TWO printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 to 3 sentences **10 × 2= 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Answer ANY FIVE of the following in brief **5 × 6= 30**

13.
14.
15.
16.
17.
18.
19.

C. Answer ANY ONE of the following in detail **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	**Number of hours**	**Total marks for which the questions are to be asked (including bonus questions)**
I	10	19
II	9	17
III	6	11
IV	6	11
V	7	14
VI	4	8
VII	3	6
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): 60		

Semester	**V**
Paper Code	**BO 5226**
Paper Title	**Plant Systematics and Ethnobotany**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practicals per semester	33
Number of practicals credits	02

COURSE OBJECTIVES (CO)	The course aims to: 1. To understand the principles of plant taxonomy and learn the morphological characters used in the identification, nomenclature, and classification of flowering plants. 2. To familiarize students with classical and modern systems of classification, and the significance of herbarium techniques. 3. To study the vegetative and floral characteristics of selected dicot and monocot families and recognize their taxonomic and economic importance. 4. To introduce the concepts and methods of biosystematics and phylogenetics, including numerical taxonomy, experimental taxonomy, and species concepts. 5. To explore molecular approaches in taxonomy by understanding the use of phytochemical, serological, and DNA-based data in plant classification. 6. To develop an appreciation for ethnobotanical knowledge and Indian Knowledge Systems (IKS) by examining traditional plant-based practices and their relevance in agriculture, medicine, and addressing global challenges.
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to 1. Recall the principles and rules of plant nomenclature and classification, including ICN guidelines and systems such as Bentham & Hooker and APG. 2. Explain the structural features of plant organs (root, stem, leaves, inflorescence, flowers, fruits) and their relevance in plant identification and taxonomy. 3. Demonstrate herbarium techniques and apply them in the preservation and documentation of plant specimens. 4. Analyse evolutionary relationships using phylogenetic terms such as monophyly, homology, synapomorphy, and clade formation. 5. Assess the significance of biosystematics and molecular tools (e.g., rbcL, matK, ITS, 18sRNA) in modern taxonomy and traditional knowledge systems and ethnobotanical practices in sustainable development.

BO 5226: Plant Systematics and Ethnobotany

Units	Title of Contents	Hrs (45)
Unit I	Introduction & Principles of taxonomy: Description - The plant body - Root, stem and leaves: types and their modifications. Inflorescence types, flower- parts and their arrangements, fruit types. Identification, Nomenclature, Classification - Principles and rules (ICN); *ranks and names; binominal system,* typification, Systems of classification - Bentham and Hooker's system, APG System of classification. Herbarium technique (conventional and digital). *Botanical Survey of India and World Flora Online.*	**11+*2***
Unit II	Vegetative and floral characters of flowering plants used in taxonomy in the description of families: Salient features of the families given below – (According to Bentham and Hooker system of classification). Dicotyledonous families: Magnoliaceae, Fabaceae, Caesalpiniaceae, Euphorbiaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Rubiaceae, Lamiaceae and Asteraceae. Monocotyledonous families: Poaceae and Musaceae. Brief economic uses of the members of the above-mentioned families. *Any 2 families can be given for self-study.*	**11+*2***
Unit III	Biosystematics: *Introduction, principle and methods.* Numerical taxonomy and experimental taxonomy. Phylogenetic systematics: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly, clades, synapomorphy, symplesiomorphy, apomorphy, lineage sorting, serial homology). Brief account on species concept. Taxonomic evidence: Role of phytochemistry and serology in taxonomy. Use of molecular data in plant taxonomy - chloroplast genes (*rbcL* and ITS), mitochondrial gene (*matK*) and nuclear gene (nuclear ribosomal 18S rRNA).	**9+*1***
Unit IV	Ethnobotany and Indian Knowledge System (IKS): *History, importance of ethnobotany. Application of ethnic knowledge on agriculture and medicinal plants.* Socio-cultural practices of Sholiga tribes of B.R. hills and Khani tribals of Kerala in relevance to plants and Non-Timber Forest Produce. Fundamentals of IKS - Definition, overview, concept and scope of IKS. Brief concept of Vrikshayurveda, Charaka Samhita, and Sushruta Samhita.	***1+8***

Note: Portions that are underlined are meant for self-study

BO 5P226: Plant Systematics and Ethnobotany

Detailed studies of the following families with locally available plant specimens (depending on availability).

Sl. No.	Experiments	Units/Sessions
1	Structure of fruits and types.	1
2	Magnoliaceae and Euphorbiaceae	1
3	Fabaceae and Caesalpiniaceae	1
4	Apiaceae and Apocynaceae	1
5	Asclepiadaceae and Solanaceae	1
6	Rubiaceae and Asteraceae	1
7	Lamiaceae and Musaceae	1
8	Visit to FRLHT - TDU, Bengaluru and preparation of report.	1
9	Preparation of questionnaire, local survey, and report submission	1
10	Economic Botany: Common name, botanical name, family to which they belong, morphology of the part being used and uses: Cereals: Rice; Millets: Ragi; Pulses: Black gram. Spices: Cardamom. Fibres: Cotton. Medicinal plants: Neem	1
11	Revision and attestation.	1

References:

- Ashok Bendre and Ashok Kumar (1980) Economic Botany. Rastogi and Publications, Meerut.
- Heywood V.H. (1967) Plant Taxonomy. Edward Arnold, London.
- Hill A.F. (1982) Economic Botany. McGraw Hill, New York.
- Jeffrey C. (1968) An introduction to plant taxonomy, London.
- Lawrence, F.H.M. (1969) Taxonomy of vascular plants. Oxford & IBH Publications, New Delhi.
- Singh and Jain, D.K. (1989) Taxonomy of angiosperms. Rastogi and Publications, Meerut.
- Sundararajan,S. (2000) College Botany Vol. III. Himalayan Publishing House, Mumbai.
- Sivarajan, V.V. (1982) Introduction to principles of plant taxonomy. Oxford & IBH Publications, New Delhi.
- B.S.Sharma and B.B. Trivedi (1978) Introductory taxonomy. L B Publications.
- Gurcharan Singh (2019) Plant Systematics: An Integrated Approach, IV Edition.CRC Press, •Simpson, M.G. (2019) Plant Systematics, 3rd Edition. Academic Press, USA.
- Harris, J.G. and Harris, M.W. (2001) Plant identification terminology: An illustrated glossary Second Edition. Spring Lake Publishing, Spring Lake, Utah.
- Beentje, H. (2010)The Kew Plant Glossary: an illustrated dictionary of plant terms. Royal Botanic Gardens, Kew,UK.
- Bell, A. D. (1991) Plant Form: An Illustrated Guide to Flowering Plant Morphology. Oxford University Press, Oxford
- Suresh G, Haridasan K, Krishnamurthy KV. Relevance of Vṛkṣāyurveda and other traditional methods for organic production of nursery seedlings of useful plants. Anc Sci

Life. 2013 Jul;33(1):60-70. doi: 10.4103/0257-7941.134613. PMID: 25161333; PMCID: PMC4140025.

- Singh Alka, Mishra H.S., Agrawal Ajay Kumar. A review on Vrikshayurveda - Upavanavinoda: Unlocking the potential of sustainable agriculture and environmental health. J Ayurveda Integr Med Sci 2023;12:212-217.

PRACTICAL EXAMINATION QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
III B.Sc. V SEMESTER - BOTANY
BO 5P226: PLANT SYSTEMATICS AND ETHNOBOTANY
BOTANY PRACTICAL EXAMINATION
MAX. MARKS: 25 **TIME: 2 HOURS 40 MINUTES**

I	Derive the specimens 'A' and 'B' to their respective families.	3x2=6
II	Describe the specimen **'C'** in technical terms.	4x1=4
III	Draw the floral diagram and write the formula for '**D'**	3x1=3
IV	Identify the specimen **'E'** and **'F'** and comment	2x2=4
V	Write the common name, botanical name, family, parts used and economic uses of **'G'** and '**H**'	2.5x2=5
VI	Submission of report	3M

KEY

A & B – Derivation of two plants up to family level from dicot and monocot classes.
C – Any one plant studied during the practical class either from Polypetalae or Gamopetalae group.
D – Any one plant studied during the practical class.
E & F – Any two type of inflorescences studied during the practical class.
G & H – Any two economic botany plants studied during the practical class.

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
III B.Sc. BOTANY – V SEMESTER, BOTANY
SEMESTER EXAMINATION
BO 5226: PLANT SYSTEMATICS AND ETHNOBOTANY

Time: 2 Hours **Max Marks: 60**

The paper contains ONE printed page and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	13	25
II	13	25
III	10	20
IV	09	16
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**V**
Paper Code	**BO 5326**
Paper Title	**Plant Biotechnology and Crop Improvement**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practical per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	This course aims to: 1. Provide understanding of basic concepts of plant biotechnology, historical developments and its recent advances; and its scope and interdisciplinary nature. 2. Demonstrate the knowledge of plant tissue culture techniques and perform basic tissue culture operations such as media preparation and sterilization. 3. Explain Genetic Engineering Tools and Gene Transfer Methods and differentiate between *Agrobacterium*-mediated and direct gene transfer techniques. 4. Evaluate Applications of Transgenic Plants and rDNA Technologies; analyze case studies of genetically modified crops (e.g., Bt Cotton, Golden Rice); discuss applications such as pest resistance, abiotic stress tolerance, bioremediation and phytoremediation. 5. Assess Ethical, Biosafety, and Regulatory Aspects; identify biosafety regulations; understand issues related to IPR, patents, and bioethics in plant biotechnology.
LEARNING OUTCOMES (LO)	After successful completion of the course, students will be able to 1. Understand the concepts of tissue culture and gene transfer techniques; describe the biotechnological tools and their applications in crop improvement. 2. Apply the plant tissue culture techniques; demonstrate the knowledge of totipotency, differentiation and organogenesis; perform callus induction and micropropagation. 3. Analyze gene transfer methods and compare the direct and indirect methods. 4. Comprehend the need for development and regulation of transgenic plants. 5. Evaluate the importance of biosafety, bioethics, regulatory frameworks, and patenting in plant biotechnology

BO 5326: Plant Biotechnology and Crop Improvement

Units	Title of contents	Hrs (45)
UNIT I	**Introduction to Biotechnology:** *Definition, scope and interdisciplinary nature.* Milestones and development of biotechnology in India and globally.	1+ *1*
UNIT II	**Plant Tissue Culture:** Definition, history, principle, scope and importance of plant tissue culture. **Micropropagation techniques:** Concept of totipotency, Differentiation types. Sterilization methods, Culture media – some important plant tissue culture media, media constituents – inorganic nutrients (macro- and micronutrients), organic nutrients (vitamins, amino acids, carbon source and undefined supplements), growth regulators, gelling agents.	5
UNIT III	**Micropropagation in plant improvement and conservation:** *Callus – types and uses.* Organ culture – Meristem culture and its importance. Organogenesis, somatic embryogenesis and artificial seeds. Germplasm conservation and applications. Single cell and suspension culture and their significance. Secondary metabolites production – Hairy root culture (principle and importance)	5+ *1*
UNIT IV	**Genetic Engineering in Plants:** Recombinant DNA technology tools: enzymes, cloning vectors (plasmids – pUC18, cosmids and YAC) and expression vectors – pCambia, Virus based vectors. Steps in construction of recombinant DNA.	5
UNIT V	**Molecular Biology Techniques and their applications:** *Agarose gel electrophoresis,* Southern, Northern and Eastern blotting blotting, *Polymerase Chain Reaction*. Restriction mapping through AGE Genomic DNA library and cDNA library construction. DNA sequencing (Sanger's method)	7+*2*
UNIT VI	**Methods of Gene transfer:** Indirect: *Agrobacterium* species mediated (Ti and Ri plasmid) Direct: PEG mediated transfer, Gene gun and electroporation Production of transgenic plants (Floral dip and cocultivation method). Selection and screening of transformed plants - selectable markers (antibiotic genes) and reporter genes (luciferase and GFP). **Genome editing:** (CRISPR-Cas9) and RNA interference (RNAi)	8
UNIT VII	**Transgenic Plants:** **Improved crop traits through genetic engineering:** pest resistance (Bt Brinjal), herbicide resistance (RoundUp ready Cotton), and abiotic stress tolerance (salt resistant rice varieties - CSR56 and CSR60). *Case studies - Golden rice and Flavr Savr tomato.* **Biotechnology in environmental monitoring:** Bioremediation (superbug) and phytoremediation.	5+*2*
UNIT VIII	Introduction to Biosafety, Biohazards and Bioethics; Intellectual Property Rights and Patenting in plant biotechnology.	3

BO 5P326: Plant Biotechnology and Crop Improvement

11 Sessions – 3 hours/ Week

Sl. No.	Experiments	Units/Sessions
1	Laboratory organization of plant tissue culture and the instruments/equipments used	1
2	Preparation and sterilization of MS medium	1
3	Initiation: Explant preparation, surface sterilization and inoculation	1
4	Isolation of plant genomic DNA (CTAB method)	1
5	Restriction digestion of plasmid DNA	1
6	DNA amplification by PCR	1
7	Separation of DNA using agarose gel electrophoresis and gel documentation	1
8	Problems on restriction mapping	1
9	Spotters: Callus, Hairy root culture, Bioreactor, Gelling agents, Potting mix for hardening, Golden rice, Bt Cotton, Greenhouse	1
10	Spotters: pUC18, pCambia, Ti/Ri plasmid, PCR, AGE, Northern blotting, Southern blotting, UV transilluminator, Gene gun and Electroporation	1
11	Revision	1

References

Text Books:

1. Chawla, H.S. 2020. Introduction to Plant Biotechnology, 3rd Edition, Oxford Univ. Press
2. Singh, B.D. 2023. Biotechnology: Expanding Horizons, 5th Edition, Medtech Science Press.
3. Sandy B Primrose &Richard M Twyman, 2006 – Principles of Gene Manipulation and Genomics. 7thEdition, Blackwell Publishers
4. Gupta, P. K. 1994. Elements of Biotechnology. Rastogi Publications. Meerut.
5. Maheshwari, P. and Rangaswamy, N.S. (Eds.) 1963. Plant tissue and organ culture.
6. Old, R.W., and Primrose, S.B. (5th Ed.) 1994. Principles of gene manipulations. Blackwell Science
7. Razdan, M.K. 1993. An introduction to plant tissue culture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
8. Reinert, J.R., and Bajaj, Y.P.S. 1977. Applied and fundamental aspects of plant cell, tissue and organ culture. Springer-Verlag, Berlin
9. Sen, S.K. and Giles, K.L. (Ed.) 1983. Plant cell culture in crop improvement. Plenum Press, New York.

10. Street, H.E. 1977. Plant tissue and cell culture, Academic Press, Berkeley, University of California.
11. Kalyan Kumar De., 1997. Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
12. Mascarenhas A.F., 1991. Hand book of Plant Tissue Culture. Indian Council of Agricultural Research. New Delhi.
13. Bajaj, Y.P.S. (Ed.) Biotechnology in agriculture and forestry. Various volumes published time to time. Springer-Verlag. Berlin
14. Bhojwani, S.S. 1990. Plant tissue culture: Applications and limitations. Elsevier Publishers, Amsterdam
15. Bhojwani, S.S., and Razdan, M.K. 1996. Plant tissue culture: Theory and Practice. Elsevier Publishers, Amsterdam.
16. Dixon, R.A. and Gonzales, R.A. (Ed.) 1994. Plant cell culture, a practical approach. 2nd Edition. Oxford University Press, Oxford
17. Malik ZainulAbdin, Usha Kiran, Kamaluddin and Athar Ali (Eds). 2017. Plant Biotechnology: Principles and Applications. Springer Singapore.
18. Pareek, K.L. and Swarnkar, P.L. 2006. Trends in Plant Tissue Culture and Biotechnology. Agro bios, Jodhpur.
19. Ignacimuthu, S. 1997. Plant Biotechnology. Oxford Publishing Co. Pvt. Ltd., New Delhi.
20. Krishnamurthy, S.L., Lokeshkumar, B.M., Rathor, S., Warraich, A.S., Yadav, S., Gautam, R.K., Singh, R.K. and Sharma, P.C. 2022. Development of Salt-tolerant Rice Varieties to Enhancing Productivity in Salt-affected Environments. Environmental Sciences Proceedings. 16(1): 30.

Reference books:

1. Grierson, D and Convey, S.N., 1988. Plant Molecular Biology Published in the USA by Chapman and Hall, New York.
2. Dubey, R.C.1993. Text Book of Biotechnology. S. Chand & Company Ltd., New Delhi.
3. Brown, T.A. 1994. Gene cloning, Chapman and Hall Pub.
4. Rashid, A. 2009. Molecular physiology and Biotechnology of Flowering plants. Narosa Publishing House Pvt. Ltd., New Delhi.
5. Slater, A., Scott, W.N. and Flower, R.M. 2008. Plant Biotechnology – the Genetic Manipulation of Plants. 2nd edition. Oxford University Press Inc., New York.
6. Draper, J. 1988. Plant Genetic Transformation and Gene Expression. Blackwell Scientific Publications, Oxford.
7. Old, R.W., and Primrose, S.B. 2004. Principles of Gene Manipulation. An introduction to Genetic Engineering. 5th Edition, Blackwell Science Publications.
8. Sambrock, J., Fritch, E.F., and Maniatis, T. 1989. Molecular cloning- a laboratory manual.
9. Potrykus, I., and Spangenberg, G. 1995. Gene transfer to plants. Springer, Berlin, Heidelberg.
10. Watson, J.D., and Baker, T.A., Bell, S.P. Gann, A. and Levine, M. 2004. Molecular Biology of Genes.

PRACTICAL EXAMINATION QUESTION PAPER PATTERN
ST JOSEPH'S UNIVERISTY, BENGALURU – 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
III B.Sc. V SEMESTER
BO 5P326 – PLANT BIOTECHNOLOGY AND CROP IMPROVEMENT
BOTANY PRACTICAL EXAMINATION

MAX. MARKS: 25 **TIME: 2 hrs 40 Minutes**

1. Perform inoculation of the given explant **A** and write the protocol for plant tissue culture **….....7 M**
2. Identify and comment on spotters - **B** & **C .....3 x 2 = 6 M**
3. Solve the given problem '**D'** on restriction mapping .....**3 M**
4. Perform genomic DNA isolation by CTAB method.....**4 M**
5. Pick a chit and answer to the questions **F** & **G** given in it .....**2.5 x 2 = 5 M**

Key:

1. **A -** Inoculation of the given explant and protocol for plant tissue culture
   Procedure – 5M, Performing inoculation – 2M .....**7 M**
2. Identify and comment on **B** & **C.....3 x 2 = 6 M**
   B – Plasmids/ PCR/ Agarose gel picture/ Gene gun/ Electrophoretic Chamber/.
   C – Callus culture/ PTC Equipments/ Hairy root culture/ Bioreactor/ Shoot/Root differentiation.
3. **D** – Restriction mapping problems.....**3 M**
4. **E** – Performance – 4 M .....**4 M**
5. **F** & **G -** Pick a chit and answer to the questions given in it. .....**2.5 x 2 = 5 M**
   (Related to transgenic plants/ PTC lab set-up/ surface sterilants/ hormones, etc)
   Each answer can be evaluated for 2.5 M and marks can be given accordingly.

THEORY EXAMINATION QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
III B.Sc. BOTANY, V SEMESTER
SEMESTER EXAMINATION
BO 5326: PLANT BIOTECHNOLOGY AND CROP IMPROVEMENT

Time: 2 Hours **Max Marks: 60**

The paper contains _____printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	02	04
II	05	10
III	06	12
IV	05	10
V	09	16
VI	08	15
VII	07	13
VIII	03	06
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**V**
Paper Code	**BO 5RM 26**
Paper Title	**Elementary Research Methodology**
Number of teaching hours per week	02
Total number of teaching hours of theory per semester	30
Number of theory credits	02

COURSE OBJECTIVES (CO)	CO1: Understand the fundamentals of scientific research including its meaning, objectives, types, and criteria of good research. CO2: Identify and formulate research problems and develop appropriate research questions and hypotheses using scientific reasoning. CO3: Acquire skills in literature review using libraries, journals, and online research databases, and understand basic research metrics and indexing. CO4: Develop scientific writing and communication skills for research articles, reviews, conference presentations, and ethical journal selection. CO5: Gain awareness of research ethics and integrity, including responsible conduct of research, plagiarism prevention, and ethical issues in human, animal, and environmental research.
LEARNING OUTCOMES (LO)	After completion of the course - LO1: Explain different types of research and evaluate the quality of research using standard criteria and research metrics such as Impact Factor, CiteScore, and i10-index. LO2: Formulate a clear research problem and construct null and alternative hypotheses with appropriate identification of variables and controls. LO3: Conduct an effective literature review using scientific databases such as Google Scholar and PubMed, and apply basic referencing styles (APA/Vancouver). LO4: Prepare well-structured scientific documents including research papers, reviews, and conference presentations, and identify credible journals while avoiding predatory publications. LO5: Apply ethical principles in research practice, demonstrate awareness of plagiarism and publication ethics, and follow ethical guidelines in human, animal, and environmentally responsible research.

ELEMENTARY RESEARCH METHODOLOGY - 30 Hours		
Unit No.	Title of Contents	30 hours
UNIT I	Introduction to Research Meaning and Objective of Research, Types of Research: Basic and applied, Criteria of productive Research, Research Databases and indexing, Impact factor, Cite Score, i10 index.	6
UNIT II	Research Problem and Literature Review Identification and formulation of research problem, Research questions and hypothesis: Null and alternative hypothesis, Variables and controls, Review of literature: Types, and importance, Use of libraries, journals and online databases (Google Scholar, PubMed – basics), Referencing styles (APA / Vancouver)	7
UNIT III	Scientific Writing and Research Communication Types of research writing and publications: Research articles, Review articles, short communications, Books and Book chapters. Selection of Journals: Open access journals, subscription and hybrid. Predatory journals, Article processing charges. Structure of a research paper: Title, abstract, introduction, materials and methods, results, discussion, conclusion and references; Conference writings: oral Presentation, Poster presentations.	7
UNIT IV	Research Ethics and Integrity Meaning and importance of ethics in scientific research, Ethical principles in research: honesty, objectivity, integrity, transparency and accountability, Responsible conduct of research Ethical issues in data collection, analysis and reporting, Fabrication, falsification and plagiarism (FFP): meaning and examples, Authorship and acknowledgment ethics. Plagiarism: Definition and types of plagiarism, Consequences of plagiarism, Prevention of plagiarism and use of plagiarism detection tools. Ethics in research involving human subjects: informed consent, confidentiality and privacy Ethics in animal experimentation: basic principles (3Rs – Replacement, Reduction and Refinement) Environmental ethics and sustainable research practices Publication Ethics: Duplicate publication and salami slicing, Conflict of interest, Peer review process: ethics and responsibilities	10

REFERENCES:
Thomas, C. G. (2021). *Research Methodology and Scientific Writing* (2nd ed.). Springer Nature. ISBN: 978-3-030-64864-0.
Booth, W. C., Colomb, G. G., Williams, J. M., Bizup, J., & FitzGerald, W. T. (2024). *The Craft of Research* (5th ed.). University of Chicago Press. ISBN: 978-0226065663.
Turabian, K. L., Booth, W. C., Colomb, G. G., Williams, J. M., Bizup, J., & FitzGerald, W. T. (2018). *A Manual for Writers of Research Papers, Theses, and Dissertations: Chicago Style for Students and Researchers* (9th ed.). University of Chicago Press. ISBN: 978-0226494425.
Saharan, V. A., Kulhari, H., & Jadhav, H. R. (Eds.). (2025). *Principles of Research Methodology and Ethics in Pharmaceutical Sciences: An Application Guide for Students and Researchers*. CRC Press. ISBN: 978-0367538002.
Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications. ISBN: 978-1506386706.

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
B.Sc. BOTANY – V SEMESTER
SEMESTER EXAMINATION
BO 5RM 26: ELEMENTARY RESEARCH METHODOLOGY

Time: 2 Hours Max Marks: 30

The paper contains TWO printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY FIVE of the following in 2 or 3 sentences $5 \times 2 = 10$
1.
2.
3.
4.
5.
6.
7.

B. Write critical notes on ANY FOUR of the following $4 \times 5 = 20$
8.
9.
10.
11.
12.
13.

BLUEPRINT

Unit No.	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	6	10
II	7	11
III	7	11
IV	10	12
TOTAL	30	44

Semester	**V**
Paper Code	**BO 5S26**
Paper Title	**Skill-based Entrepreneurship in Plant Sciences I**
Number of teaching hours per week	03
Number of practical credits	02
Total number of teaching hours of practical per semester	33

COURSE OBJECTIVES (CO)	CO1: To provide practical knowledge of sustainable cultivation techniques including mushroom farming, hydroponics, Spirulina culture, and vermicomposting. CO2: To introduce specialized biological techniques such as airborne pollen isolation and analysis. CO3: To promote understanding of resource-efficient agricultural practices for food, nutrition, and environmental sustainability. CO4: To bridge theoretical learning with field applications through industrial and research institution visits. CO5: To foster entrepreneurship, innovation, and career readiness in agriculture, biotechnology, and allied sectors.
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to - LO1: Demonstrate practical skills in selected plant, fungal, algal, and compost production methods. LO2: Prepare and manage culture systems, nutrient solutions, and substrates for sustainable cultivation. LO3: Operate equipment and apply techniques for aerobiological studies such as pollen isolation. LO4: Analyze and connect academic concepts with field-level practices observed during industrial visits. LO5: Evaluate opportunities for entrepreneurship and sustainable production in agriculture and allied fields

BO 5S26: Skill-based Entrepreneurship in Plant Sciences I - 33 Hours		
Practical 1	Mushroom cultivation - 2 sessions	6 hrs
Practical 2	Hydroponics - 2 sessions	6 hrs
Practical 3	Cultivation of *Spirulina*	3 hrs
Practical 4	Vermicomposting	3 hrs
Practical 5	Isolation of pollen from air - technique	3 hrs
Practical 6	Industrial visit - IIHR, IWST, GKVK, IAHS	12 hrs

REFERENCES

-

EXAMINATION PATTERN

- PIA – 25 marks
- ESE – 25 marks

Semester	**VI**
Paper Code	**BO 6126**
Paper Title	**Ecology, Forestry and Conservation Science**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practicals per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	**This course aims to:** 1. Understand and explain fundamental ecological concepts including ecosystem structure, function, energy flow, succession, and adaptations in plants. 2. Apply quantitative and qualitative methods for vegetation analysis, biodiversity estimation, and ecological indices (e.g., Shannon, Simpson, IVI). 3. Critically analyze the impact of invasive species, global environmental issues, and biogeochemical cycles in the context of ecological resilience and sustainability. 4. Demonstrate practical skills in biodiversity monitoring, habitat mapping, remote sensing, and carbon estimation using standard ecological tools and geospatial technologies. 5. Interpret and evaluate conservation policies, biodiversity laws, and resource management strategies, with a focus on community-based and sustainable practices. 6. Develop an ethical and environmentally responsible approach to conservation challenges in line with national policies and the United Nations Sustainable Development Goals (SDGs).
LEARNING OUTCOMES (LO)	**After completion of the course, students will be able to:** 1. Explain key ecological principles, including niche, succession, trophic interactions, and plant adaptations across ecosystems and biomes. 2. Demonstrate field-based skills in vegetation analysis and biodiversity assessment using parameters like DBH, basal area, IVI, and diversity indices. 3. Apply geospatial tools and remote sensing indices (NDVI, EVI, SAVI) to monitor vegetation health, assess ecological changes, and support conservation research. 4. Evaluate biodiversity threats and conservation strategies, including in- situ/ex-situ methods, IUCN classifications, and community-based natural resource management. 5. Interpret national environmental laws, estimate carbon storage, and promote sustainability through environmental impact assessment and eco-friendly practices.

BO6126: Ecology, Forestry and Conservation Science

Units	Title of Contents	Hrs (45)
UNIT I	**Fundamentals of Ecology and Ecosystem Functioning**	**15 Hrs**
	Introduction to Ecology: Definition, scope, subdivisions, and applied branches	**1**
	Levels of organization in Ecology: Population, community, and ecosystem	**1**
	Ecological Interactions: Positive and Negative Ecological Interactions. a) Commensalism (Epiphytes-*Orchid* and Lianas-*Entada/Ficus pumila/Bauhinia vahli*) b) Protocooperation (Gut bacteria *E. coli* and *Enterococcus faecalis*) c) Mutualism (*Rhizobium,* Lichens and Mycorrhiza) d) Parasitism (*Cuscuta, Rafflesia, Viscum and Santalum*) e) Allelopathy (*Eucalyptus*)	**2**
	Ecosystem - Structure and Function: Biotic components and abiotic factors - Climatic factors - Light and Temperature; *Soil profile; Edaphic factors affecting vegetation (soil water, soil microbes, and pH – (Self-study))*, food chains, food webs, trophic levels, ecological pyramids.	**3+*1***
	Productivity: NPP and GPP**; Energy flow:** 10% rule; **Biogeochemical Cycles** - Gaseous cycles - (Nitrogen cycle) and Sedimentary cycles (Phosphorous cycle).	**3**
	Ecological Niches and Adaptations: Habitat vs niche, Ecological Niche Modeling. Plant evolution and types of adaptations.	**2**
	Ecological successions: Process and examples; hydrosere and xerosere *(Self-study).*	**1+*1***
UNIT II	**Forestry Science and Monitoring**	**15 Hrs**
	Population Ecology - Characteristics of Population: size, density, abundance, natality, mortality, age structure, dispersal.	**3**
	Community Ecology: Quantitative estimation of vegetation; DBH, Shannon Diversity Index, Simpson Index, density, frequency, basal area, and IVI	**3**
	The world's biomes: Aquatic (Freshwater and Marine), *Desert (Self-Study)*, Forest, *Grassland,* and *Tundra biomes (Self-Study)*	**2+*1***
	Invasive Alien Species (IAS): Issues and Prospects with suitable examples	**1**
	Fundamentals of Remote Sensing and GIS: Concept of Remote Sensing and GIS **Vegetation Indices and Applications:** NDVI, EVI, SAVI, principles and uses; Applications in vegetation health, biomass, and phenology monitoring; case studies on the application of remote sensing in forestry and agriculture	**3**

	Contemporary Environmental Issues and SDGs: Climate Change, Global Warming, Ozone Layer Depletion *(Self-Study)* and SDGs	**1+*1***
UNIT III	**Conservation Science and Management**	**15 Hrs**
	Biodiversity: Definition, Convention on Biological Diversity (CBD); threats to biodiversity; IUCN Red List categories and criteria, Biodiversity hotspots in India.	**3**
	Conservation terminologies: Keystone species, flagship species, umbrella species, indicator species	**1**
	Conservation strategies: *in-situ:* Medicinal Plant Conservation Areas (MPCAs), Protected Areas (PAs), and *ex-situ*: Botanical Gardens, Seed banks and Gene banks.	**3**
	An overview of conservation laws in India: (The Biological Diversity Act, 2002; The Environment (Protection) Act, 1986; The Forest (Conservation) Act, 1980; The Wildlife Protection Act, 1972; The Indian Forest Act, 1927) *(Self-study).*	***2***

	Natural Resource Management and Community-based Conservation: Non- timber Forest Products (NTFPs), Traditional Ecological Knowledge (TEK), Joint Forest Management (JFM), Sacred Groves.	**3**
	Carbon sequestration and carbon trading, carbon footprint, Environmental Impact Assessment (EIA); Biodiversity Impact Assessment (BIA).	**3**

BO 6P126: ECOLOGY, FORESTRY AND CONSERVATION SCIENCE

11 Sessions – 3 hours/ Week

Sl. No.	List of Experiments	Units/ Sessions
1	Vegetation assessment tools and techniques - GPS, Quadrat, Clinometer, Compass, Vernier Calipers, Densiometer, DBH & measuring tapes, Ropes, etc.	1
2	Enumeration of campus flora and IVI Calculation	1
3	Calculation of Shannon Diversity Index	1
4	Estimation of Carbon storage in a given tree species	1
5	Ecological Adaptations – Set 1 (Xerophytes, Hydrophytes)	1
6	Ecological Adaptations – Set 2 (Halophytes, Epiphytes, Parasitic plants)	1
7	Study of common Invasive Alien Species in India – *Lantana, Parthenium, Alternanthera*	1
8	Questionnaire survey to address conservation issues	1
9	Mapping of Protected Areas using QGIS - Demonstration	1
10	Waste to wealth; paper-making from dry leaves/seedball making using paper pulp/dried leaf art and eco-greeting cards/seed jewellery/used plastic bottle art and crafts	1
11	Revision	1

Text Books and Articles:

1. Foin, T.C. (1996) Ecological System and Environment, Mifflin, Boston.
2. Fred Van Dyke, (2008) Conservation Biology: Foundations, Concepts, Applications, 2nd Edition, Springer, Dordrecht.

3. Heywood, V.H. and Watson R.T. (1995) Global Biodiversity Assessment, Cambridge University Press.
4. Kormondy, E.J. (1996) Concepts of Ecology, Prentice Hall India, New Delhi.
5. Martha J. Groom, Gary K. Meffe, C. Ronald Carroll, (2014) Principles of Conservation Biology, Oxford University Press, UK.
6. Mueller-Dombois, D. and Ellenberg, H. (1974) Aims and Methods of Vegetation Ecology, John Wiley and Sons, New York.
7. Nobel, B.J. and Wright R.T. (1995) Environmental Science, Prentice Hall, New Jersey.
8. Odum, E. P., & Barrett, G. W. (2017). Fundamentals of ecology (5th ed.). Brooks/Cole.
9. Pandey, B.W. (2005) Natural Resource Management, Mittal Publication, New Delhi.
10. Sharma, P.D. (2003) Ecology and Environment. 7th Edition, Rastogi Publication, Meerut.
11. Wittenberg, R. and Cock, M.J.W. (eds.) 2001. Invasive Alien Species: A Toolkit of Best Prevention and Management Practices. CAB International, Wallingford, Oxon, UK, xvii - 228.
12. Cohen, M., Wohlmuth, H., Williams, C., & Clarke, P. (2023). The evolutionary pathways and ecological adaptations of plants: A comprehensive analysis of survival strategies over geological timescales. Australian Herbal Insight, 1(5), 1-5. https://doi.org/10.25163/ahi.619966
13. Wilson EO (ed.) (1988) Biodiversity. National Academy Press, Washington, D.C.
14. Stephen, A., Suresh, R., & Livingstone, C. (2015). Indian biodiversity: Past, present and future. International Journal of Environment and Natural Sciences, 7, 13-28.

PRACTICAL EXAMINATION QUESTION PAPER PATTERN

ST. JOSEPH'S UNIVERSITY, BENGALURU - 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
III B.Sc. VI SEMESTER - BOTANY PRACTICAL EXAMINATION
BO 6P126- ECOLOGY, FORESTRY AND CONSERVATION SCIENCE

MAX. MARKS: 25 **TIME: 2 HOURS 40 MINUTES**

1.	Determine the Importance Value Index (IVI) of the given vegetation **A** through the quadrat sampling method, and calculate the Shannon Diversity Index	4 M+2M
2.	Identify, draw and comment on the ecological adaptations of **B, C, and D**	3 X 3 = 9 M
3.	Identify and comment on **E** and **F** with a labelled diagram	2 X 2.5 = 5 M
4.	Submission of survey report	3 M
5.	Submission of Waste to Wealth	2 M

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU – 560027
SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
III B.Sc. (BOTANY) VI SEMESTER
BO 6126 – ECOLOGY, FORESTRY AND CONSERVATION SCIENCE
END SEMESTER EXAMINATION

TIME:2 HOURS **MAX. MARKS:60**

The paper contains ONE printed page and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 to 3 sentence **10× 2= 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Answer ANY FIVE of the following in brief **5 × 6= 30**

13.
14.
15.
16.
17.
18.
19.

C. Answer ANY ONE of the following in detail **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	15	28
II	15	29
III	15	29
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**VI**
Paper Code	**BO 6226**
Paper Title	**Seed Technology, Plant breeding and Propagation**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03
Total number of teaching hours of practicals per semester	33
Number of practical credits	02

Course objectives	**This course aims to:** 1. Provide understanding on the fundamentals of seed biology, including structure, formation, dormancy, germination, and seed-borne diseases. 2. Gain insights into national seed laws, seed certification, and quality assessment methods. 3. Explore classical and modern plant breeding techniques, including hybridization, molecular markers, and population genetics. 4. Develop skills in vegetative propagation and modern plant propagation technologies, including hydroponics and aeroponics. 5. Apply theoretical knowledge in practical contexts through lab-based exercises and field techniques such as viability testing and hybridization experiments.
Learning outcomes	By the end of this course, the students will be able to: 1. Describe the structure, development, and formation process of monocot and dicot seeds. 2. Explain seed viability, dormancy, and seed-borne diseases, including methods for testing, control, and dormancy breaking. 3. Classify types of seeds and interpret the Indian Seed Act and seed certification procedures. 4. Differentiate among mass, pure line, and clonal selection methods used in plant breeding. 5. Apply hybridization techniques and explain the role of apomixis in hybrid seed production. 6. Evaluate modern breeding tools, including molecular markers, population genetics, artificial propagation, hydroponics, and aeroponics.

BO 6226: Seed Technology, Plant breeding and Propagation		
Units	**Title of Contents**	**Hours (45)**
	SEED TECHNOLOGY	**15 hours**
UNIT I	**Seed Technology** – scope and objectives. Development and progress of Seed Industry/Technology in India and its importance in agriculture. **Formation of seed**: Pollination, pollinating agents, and fertilization. **Seed production:** General principles of seed production, seed production in self- and cross-pollinated crops. Classes of seeds in agriculture – nucleus, breeder, foundation and certified seeds. **Apomixis** – types and significance, role of apomixis in hybrid seed production. *Components of a seed. Difference between seed and grain.* Structure of monocot and dicot seeds with examples, diversity of biochemical composition of seeds.	6 + *1*
UNIT II	**Seed processing:** Harvesting - seed drying, seed cleaning and grading, equipment needed. **Seed Storage:** types of storage structures with special reference to cold storage (for long-term storage). Inherent seed characteristics (seed factors) and environmental conditions that affect the storage life of seeds. Orthodox and recalcitrant seeds. **Seed dormancy:** types and dormancy breaking treatments. Seed priming. Role of microbes in seed treatment. Seed treatment with *Trichoderma* - Case study. ***Seed deterioration:*** *factors involved and control measures.* **Seed quality testing:** Seed health, seed viability tests. Mechanism of seed germination and factors affecting. Marketing of seeds – an entrepreneurship perspective. **Seed certification** – principles and steps involved. Protection of Plant Varieties and Farmers' Rights (PPV& FR) Act, 2001. National Seed Programme. Indian Seed Act (1966).	7 + *1*
	PLANT BREEDING AND PROPAGATION	**30 hours**
UNIT III	**Concepts of plant breeding** – history, objectives, and achievements in plant breeding. Centres of origin of cultivated plants (Vavilov Concept). *Contributions of M.S. Swaminathan.*	1 + *1*

UNIT IV	Gene pool and genetic basis of plant breeding. Evolutionary forces shaping plant populations – mutation, gene flow, genetic drift and natural selection.	3
UNIT V	Selection methods – mass selection (*Zea mays*), pure line (*Phaseolus vulgaris*), clonal selection (*Saccharum officinarum* or *Solanum tuberosum*); Merits and demerits of selection methods. Back cross technique in crop improvement.	4
UNIT VI	**Hybridization** – concepts, merits and demerits; Techniques of hybridization - Selection and evaluation of parents, emasculation, bagging, tagging, pollination, collection, storage of F_1. *Male sterility – methods of introduction, and application*; Self-incompatibility – mechanism, types, methods of induction, and applications. Heterosis and inbreeding – genetic basis of heterosis, inbreeding depression, advantages, and disadvantages.	6 + *1*
UNIT VII	**Molecular Markers in Plant Breeding:** Introduction to different types of molecular markers (e.g., QTL, SSR, & SNP) and their applications in assessing genetic diversity. Markers in disease resistance. Microbiome-assisted breeding.	4
UNIT VIII	**Plant propagation** – *History, scope and importance.* **Tools and Equipment of Propagation:** propagation structures - green house equipment, and media. Role of auxins in rooting. Factors that affect the successful propagation of plants. **Vegetative propagation methods of some selected plants:** **Techniques of propagation by cuttings:** Stem cuttings – Jasmine and *Hibiscus*, and leaf cuttings. **Biology and techniques of grafting:** Whip and tongue, wedge and cleft, and approach grafting. **Techniques of budding:** T-budding, chip budding, and ring budding. **Layering and its natural modifications:** Simple layering, air layering, and trench layering. Clonal propagation, Micropropagation and Germplasm conservation. Vertical farming. *Concept of hydroponics, and aeroponics.*	8 + *2*

NOTE: Portions (6 hours) that are underlined are meant for self-study

BO 6P226: Seed Technology, Plant breeding and Propagation Total: 33 Hours (11 Sessions and 3 hrs per week)		
Sl. No.	**Experiments**	**Units/Sessions**
1	Seed viability and Seed purity tests (TTC method, Seed moisture, Pure seeds separation, Seed vigour).	1
2	Seed priming – using PEG, osmopriming, hydropriming.	1
3	Study of floral biology of crops- typical examples of self- and cross-pollinated plants.	1
4	Hybridization experiments – emasculation and bagging in self- and cross-pollinated crops/plants.	1
5	Pollen viability tests – germination test, pollen storage	1
6	Detection of mycoflora of stored seed samples by SMT/ PDA method.	1
7	Plant propagation techniques – cutting (hibiscus, pothos), grafting (citrus, rose), layering (jasmine, vinca).	1
8	Propagation by modified stems (ginger rhizomes, potato tubers) and leaves (*Bryophyllum, Aloe*).	1
9	Propagation by modified roots (Sweet potato, Dahlia, Asparagus)	1
10	Pot and greenhouse implants (demonstration)	1
11	Revisions	1

References:

Seed Technology:

1. **Agrawal, P. K.** (1995). *Seed Technology*. Oxford & IBH Publishing Co.
2. **Kumar, D.** (2005). *Seed Technology*. Scientific Publishers.
3. **Copeland, L. O. & McDonald, M. B.** (2001). *Principles of Seed Science and Technology*. Springer.
4. **Desai, B. B., Katecha, P. M., & Salunkhe, D. K.** (1997). *Seed Handbook: Biology, Production, Processing, and Storage*. Marcel Dekker Inc.
5. **Singh, B. D.** (2012). *Seed Science and Technology*. Kalyani Publishers.
6. **Copeland, L. O. & McDonald, M. B.** (2001). *Principles of Seed Science and Technology*. Springer. *(USA)*
7. **Bewley, J. D., Bradford, K., Hilhorst, H., &Nonogaki, H.** (2013). *Seeds: Physiology of Development, Germination and Dormancy*. Springer. *(USA)*
8. **Desai, B. B., Katecha, P. M., & Salunkhe, D. K.** (1997). *Seed Handbook: Biology, Production, Processing, and Storage*. Marcel Dekker Inc. *(USA)*
9. **Agrawal, P. K.** (1995). *Seed Technology*. Oxford & IBH Publishing Co. *(India)*
10. **Vanangamudi, K.** (2014). *Seed Science and Technology*. Scientific Publishers. *(India)*
11. Baskin, C. C., and Baskin, J. M. (2014). Seeds: Ecology, biogeography, and evolution of

dormancy and germination (2nd ed.). Academic Press.
12. THE SEEDS ACT (1966). https://www.indiacode.nic.in/bitstream/123456789/1712/1/196654.pdf
13. Baskin, C. C., and Baskin, J. M. (2007). A revision of Martin's seed classification system, with particular reference to his dwarf-seed type. Seed Science Research, 17(1), 11–20. https://doi.org/10.1017/S0960258507383189

Plant Breeding:

1. **Chopra, V. L.** (2015). *Plant Breeding: Theory and Practice*. Oxford & IBH Publishing.
2. **Singh, B. D.** (2021). *Plant Breeding: Principles and Methods*. 11th ed., Kalyani Publishers.
3. **Allard, R. W.** (1999). *Principles of Plant Breeding*. John Wiley & Sons.
4. **Poehlman, J. M. & Sleper, D. A.** (1995). *Breeding Field Crops*. Blackwell Publishing.
5. **Acquaah, G.** (2012). *Principles of Plant Genetics and Breeding*. Wiley-Blackwell.
6. **Allard, R. W.** (1999). *Principles of Plant Breeding*. John Wiley & Sons. *(USA)*
7. **Acquaah, G.** (2012). *Principles of Plant Genetics and Breeding*. Wiley-Blackwell. *(USA/Ghana)*
8. **Poehlman, J. M. & Sleper, D. A.** (1995). *Breeding Field Crops*. Blackwell Publishing. *(USA)*
9. **Singh, B. D.** (2021). *Plant Breeding: Principles and Methods*. 11th ed., Kalyani Publishers. *(India)*
10. **Chopra, V. L.** (2015). *Plant Breeding: Theory and Practice*. Oxford & IBH Publishing. *(India)*

Plant Propagation:

1. **Hartmann, H. T., Kester, D. E., Davies, F. T. Jr., & Geneve, R. L.** (2014). *Plant Propagation: Principles and Practices*. 8th ed., Prentice Hall. *(USA)*
2. **Hartmann, H. T., & Kester, D. E.** (1983). *Plant Propagation: Principles and Practices*. *(Classic earlier editions)*
3. **Sadhu, M. K.** (2005). *Plant Propagation*. New Age International Publishers. *(India)*
4. **Bose, T. K., Mitra, S. K., & Sadhu, M. K.** (1991). *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash. *(India)*
5. **Hartmann, H. T., Kester, D. E., Davies, F. T. Jr., & Geneve, R. L.** (2014). *Plant Propagation: Principles and Practices*. 8th ed., Prentice Hall.
6. **Sadhu, M. K.** (2005). *Plant Propagation*. New Age International Publishers.
7. **Bose, T. K., Mitra, S. K., & Sadhu, M. K.** (1991). *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash.
8. **Alan Toogood (Ed.) 1999.** Plant Propagation. American Horticultural Society.

Special Topics & Supplementary

1. **Sharma, J. R.** (1994). *Principles and Practice of Plant Breeding*. Tata McGraw Hill.
2. **Vanangamudi, K.** (2014). *Seed Science and Technology*. Scientific Publishers.

References on Microbiome Assisted breeding –

1. DOI: 10.1104/pp.17.00325
2. DOI: 10.1016/j.tplants.2019.02.010
3. DOI: 10.1371/journal.pbio.2001793
4. DOI: 10.1038/s41579-022-00682-z

PRACTICAL EXAMINATION QUESTION PAPER PATTERN

ST. JOSEPH'S UNIVERSITY, BENGALURU - 560027

SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY

III B.Sc., VI Semester BOTANY - PRACTICAL EXAMINATION

BO 6P226- Seed Technology, Plant Breeding and Propagation

MAX. MARKS: 25 **TIME: 2 hrs. 40 Min.**

1	Perform seed viability test/Seed moisture determination for A	**6**
2	Perform pollen viability test for B	**5**
3	Identify and comment on C and D	**2.5 x 2 = 5**
4	Write the procedure for experiment 'E'	**4**
5	Pick a chit and answer to the questions F and G given in it.	**2.5 x 2 = 5**

Key:

1. **A –** Seed viability/ Seed moisture determination
   Procedure – 3 M; Performing – 3 M. ..... **6 M**
2. **B** – Pollen viability test/ Pollen germination
   Procedure – 2 M; Performing – 3 M. ..... **5 M**
3. **C** – Emasculation/Bagging/Labeling/ Potting mix/ tools/ equipment
   D – Photos of plant breeders/ Propagation methods – cutting, grafting, layering.
   ……2.5 x 2 =5 M
4. **E** – Procedure on Seed priming/ Propagation by roots, stems and leaves ..... **4 M**
5. **F** & **G -** Pick a chit and answer to the questions given in it..... **2.5 x 2 = 5 M**
   (Related to Seed technology/plant breeding and propagation)
   Each answer can be evaluated for 2.5 M and marks can be given accordingly.

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027
III B.Sc. BOTANY, VI SEMESTER
END SEMESTER EXAMINATION
BO 6226: Seed Technology, Plant Breeding and Propagation

Time: 2 Hours **Max Marks: 60**

The paper contains _____printed pages and THREE parts
Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OF THEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	07	12
II	08	16
III	02	04
IV	03	06
V	04	08
VI	07	12
VII	04	08
VIII	10	20
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**VI**
Paper Code	**BO 6326**
Paper Title	**Biostatistics, Bioinformatics and Computational Biology**
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of credits	03
Total number of teaching hours of practical per semester	33
Number of practical credits	02

COURSE OBJECTIVES (CO)	The course aims to: 1. Explain fundamental statistical concepts including data types, sampling techniques, and data presentation methods relevant to biological sciences. 2. Apply descriptive and inferential statistical tools—such as measures of central tendency, dispersion, t-tests, correlation, regression, and ANOVA—to analyze biological data. 3. Identify and retrieve information from key biological databases such as GenBank, UniProt, PDB, KEGG, and STRING for genomic, proteomic, and metabolic data. 4. Perform sequence analysis and structural bioinformatics techniques including BLAST, ClustalW, homology modeling, and visualization using tools like MEGA and PyMOL. 5. Evaluate bioinformatics tools and computational approaches for applications in drug discovery, including virtual screening, target identification, and ADMET predictions.
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to 1. Differentiate between types of biological data and apply appropriate sampling and data presentation techniques in the context of biological research. 2. Calculate and interpret statistical measures such as mean, standard deviation, p-values, and correlation coefficients to draw meaningful conclusions from experimental data. 3. Identify major bioinformatics databases and retrieve nucleotide, protein, and pathway information for use in biological investigations. 4. Perform sequence alignment and construct phylogenetic trees using bioinformatics tools such as BLAST, ClustalW, and MEGA.

	5. Apply computational tools to model protein structures and explore applications of bioinformatics in drug discovery, including virtual screening and ADMET analysis.

BO6326: Biostatistics, Bioinformatics and Computational Biology

Units	Title of Contents	Hrs (45)
UNIT I	**Introduction to Biostatistics** *Definition, scope, and importance of biostatistics in biology (Self Study)* *Applications of biostatistics in ecology, genetics, and biomedical research (Self Study)* Basic concepts of population and sample Types of data: qualitative vs. quantitative, primary vs. secondary Measurement scales: nominal, ordinal, interval, ratio Sampling techniques: Probability and non-probability sampling Data presentation: tabulation, frequency distribution, graphs (histogram, bar diagram, pie chart, line graph)	**4+*2***
UNIT II	**Descriptive Statistics and Probability** Measures of central tendency: mean, median, mode Measures of dispersion: range, variance, standard deviation, standard error Probability: basic concepts, rules, and simple applications in biological sciences Normal distribution and its applications in biological data	**4**
UNIT III	**Inferential Statistics** Hypothesis formulation: null and alternative Types of errors: Type I & II errors, significance level (p-value) t-test (independent and paired samples) Correlation (Pearson's & Spearman's) and regression basics One-way ANOVA (concept and application in biological studies), chi square test	**5**
UNIT IV	**Introduction to Bioinformatics** *Aim and branches of Bioinformatics,* Application of Bioinformatics. Basic biomolecular concepts: *Protein and amino acid, DNA & RNA, Sequence,* structure and function	**1+*2***

UNIT V	**Biological data and databases** Types of Biological data *Genomic DNA, Complementary DNA, Recombinant DNA, Expressed sequence tags,* Sequence-Tagged Sites, Genomic survey sequences. **Primary Databases** Nucleotide sequence Databases: GenBank, EMBL, DDBJ. Protein sequences Databases: Swiss-Prot, TrEMBL, UniProt. **Secondary Databases** Protein structure databases: PDB, NDB, MMDB. **Specialized Databases** Metabolic pathway database: KEGG Gene expression database: GEO Protein-Protein interaction database: STRING Plant Genome Databases:, Phytozome, The Arabidopsis Information Resource (TAIR)	**12+*2***
UNITVI	**Sequence Analysis and Structural Bioinformatics** Pairwise sequence alignment: BLAST, FASTA, scoring matrices. Multiple sequence alignment: ClustalW, MUSCLE. Phylogenetic analysis: Building phylogenetic trees using MEGA server Protein structure prediction: Homology modelling, Molecular modelling: Visualizing and analysing protein structures using PyMOL.	**8**
UNIT VII	**Applications of Bioinformatics** Drug discovery: Virtual screening, drug target identification, ADMET, PASS.	**5**

BO 6P326 Biostatistics, Bioinformatics and Computational Biology

11 Sessions – 3 Hours/ Week

Sl. No.	Experiments	Sessions
1.	Data collection, data cleaning, and data organization	1
2.	Data analysis in MS Office Excel	1
3.	Data analysis using the statistical software PAST	1
4.	Exploring biological databases like NCBI, TAIR etc.	1
5.	Sequence extraction from databases and MSA using ClustalW, MUSCLE etc.	1
6.	BLAST analysis and interpretation of BLAST results: E-value, score, identity	1
7.	Construction of phylogenetic trees using **MEGA**	1
8.	Analysing protein structures using tools like PyMOL, RasMol etc.	1
9.	Molecular docking using Auto dock Vina	1
10.	Minor/Mini/Short-term project report submission on Bioinformatics/Biostatistics	1
11.	Revision	1

References

1. Bailey, N. T. J. (1995). Statistical Methods in Biology (3rd Ed.). Cambridge University Press.
2. Baxevanis, A. D., & Ouellette, B. F. F. (2001). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2nd Ed.). Wiley & Sons.
3. Borodovsky, M., & Ekisheva, S. (2006). Problems and Solutions in Biological Sequence Analysis (1st Ed.). Cambridge University Press.
4. Bourne, P. E., & Weissig, H. (Eds.). (2003). *Structural Bioinformatics*. Wiley-Liss.
5. Bower, J. M., & Bolouri, H. (2011). Computational Modeling of Genetic and Biochemical Networks. MIT Press.
6. Dutta, N. K. (2004). Fundamentals of Biostatistics. Kanishka Publishers.
7. Ghosh, Z., & Mallick, B. (2008). Bioinformatics: Principles and Applications. Oxford University Press.
8. Gurumani, N. (2005). An Introduction to Biostatistics. MJP Publishers.
9. Hancock, J. M., & Zvelebil, M. J. (2014). Concise Encyclopaedia of Bioinformatics and Computational Biology (2nd ed.). Wiley-Blackwell.
10. Pagano, M., & Gauvreau, K. (2007). Principles of Biostatistics. Brooks/Cole.
11. Pevzner, P. A., & Compeau, P. (2015). Bioinformatics Algorithms. Active Learning Publishers.
12. Rohatgi, V. K., & Saleh, A. K. M. (2001). An Introduction to Probability and Statistics. Wiley & Sons.
13. Sundar Rao, P. S. S., & Richard, J. (1996). An Introduction to Biostatistics (3rd Ed.). Prentice Hall India.
14. van Emden, H. F. (2019). Statistics for Terrified Biologists (2nd ed.). Wiley-Blackwell.
15. Wong, K.-C. (Ed.). (2016). *Computational Biology and Bioinformatics: Gene Regulation* (Vol. 1). Springer.
16. Xiong, J. (2006). *Essential Bioinformatics*. Cambridge University Press.

PRACTICAL EXAMINATION QUESTION PAPER PATTERN

ST. JOSEPH'S UNIVERSITY, BENGALURU - 560027 SCHOOL OF LIFE SCIENCES, DEPARTMENT OF BOTANY
III B.Sc. V I SEMESTER
BO 6P326 Biostatistics, Bioinformatics and Computational Biology
BOTANY PRACTICAL EXAMINATION

MAX. MARKS: 25 **TIME: 2 HOURS 40 MINUTES**

I	Perform the given biostatistics problem	5
II	Perform the given bioinformatics problem	5
III	Project submission	10
IV	Viva	5

THEORY QUESTION PAPER PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 560027 III
B.Sc. BOTANY – VI SEMESTER
SEMESTER EXAMINATION
BO 6326: Biostatistics, Bioinformatics and Computational Biology

Time: 2 Hours **Max Marks: 60**

The paper contains TWO printed pages and THREE parts Draw diagrams and provide examples wherever necessary

A. Answer ANY TEN of the following in 2 or 3 sentences **10 × 2 = 20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Write critical notes on ANY FIVE of the following **5 × 6 = 30**

13.
14.
15.
16.
17.
18.
19.

C. Give a comprehensive account on ANY ONE of the following **1 × 10 = 10**

20.
21.

BLUEPRINT OFTHEORY EXAMINATION QUESTION PAPER PATTERN

Unit number	Number of hrs.	Total marks for which the questions are to be asked (including bonus questions)
I	06	12
II	04	08
III	05	10
IV	03	06
V	14	26
VI	08	14
VII	05	10
TOTAL	**45**	**86**
Note: Maximum marks for the paper (Excluding bonus question): **60**		

Semester	**VI**
Paper Code	**BO 6S26**
Paper Title	**Skill-based Entrepreneurship in Plant Sciences II**
Number of teaching hours per week	03
Number of practical credits	02
Total number of teaching hours of practical per semester	33

COURSE OBJECTIVES (CO)	**CO1:** To understand the principles and methods of extracting bioactive compounds from plants. **CO2:** To develop skills in essential oil extraction techniques and their applications. **CO3**: To learn the isolation and identification processes for fungal endophytes. **CO4:** To gain proficiency in advanced analytical tools such as HPLC and TLC. **CO5:** To expose students to industrial applications and research practices in natural product industries.
LEARNING OUTCOMES (LO)	After completion of the course, the students will be able to - **LO1:** Demonstrate the ability to extract and purify secondary metabolites and essential oils from plant sources. **LO2:** Isolate, culture, and identify fungal endophytes using standard microbiological techniques. **LO3:** Operate and interpret results from HPLC and TLC for compound analysis. **LO4:** Evaluate the quality and yield of bioactive compounds through analytical tools. **LO5:** Understand industrial workflows and research methodologies through visits to CIMAP and Kapiva.

BO 6S26: Skill-based Entrepreneurship in Plant Sciences II – 33 Hours		
Practical 1	Extraction of secondary metabolites from plants	6 hrs
Practical 2	Extraction of essential oils	6 hrs
Practical 3	Isolation and identification of fungal endophytes	3 hrs
Practical 4	Tools and techniques - HPLC	3 hrs
Practical 5	Tools and techniques - TLC	3 hrs
Practical 6	Industrial visit - CIMAP, Kapiva	12 hrs

REFERENCES

-

EXAMINATION PATTERN

- PIA – 25 marks
- ESE – 25 marks

Semester	**VI**
Paper code	**BO 6PR26**
Paper Title	**Research Project and Dissertation**
Number of teaching hours per week	04
Total number of contact hours per semester	60
Number of credits	04

COURSE OBJECTIVES (CO)	**CO1:** To provide students with hands-on experience in planning and executing a scientific research project individually or in groups. **CO2:** To develop the ability to identify research problems, formulate hypotheses, and apply appropriate experimental or analytical methodologies. **CO3:** To enhance skills in data collection, statistical analysis, interpretation, and scientific documentation. **CO4:** To strengthen scientific communication skills through thesis writing, oral presentation, and defense of research findings.
LEARNING OUTCOMES (LO)	After completion of the course - **LO1:** Identify and define a research problem and design a systematic approach to investigate it. **LO2:** Apply appropriate laboratory techniques, analytical tools, or field methods to generate and analyze scientific data. **LO3:** Prepare a structured research thesis following standard scientific format and ethical guidelines. **LO4:** Present and defend research findings effectively before an academic panel, demonstrating critical understanding and analytical reasoning.

Research at the B.Sc. level is not merely an academic requirement but a transformative learning experience. It cultivates scientific inquiry, professional skills, and intellectual independence, preparing students for advanced studies, research careers, and responsible scientific citizenship. Final-year B.Sc. students shall undertake a research project, either individually or in groups, as part of the curriculum. The project is intended to provide hands-on research experience and to enhance analytical, technical, and scientific communication skills.

Guidelines for evaluation

Assessment Pattern

1. **Continuous Assessment (30 marks)**
    - Regular monitoring of progress by the project supervisor
    - Evaluation of literature review, experimental design, methodology, and data collection
    - Assessment of laboratory performance, record maintenance, and participation
    - Periodic presentations or progress reports
2. **End-Semester Evaluation**

- Final oral presentation (seminar/viva voce) before an evaluation panel **(20 marks)**
- Assessment of understanding of the research topic, methodology, results, and conclusions
- Evaluation of communication skills and ability to answer questions

3. **Thesis Submission (30 marks)**
    - Each student shall submit an individual **project dissertation/thesis**, even in the case of group projects
    - The thesis must include abstract, introduction, review of literature, objectives, methodology, results, discussion, conclusion, references, and acknowledgments
    - The dissertation shall be evaluated by **external examiners**, along with internal assessment

Continuous assessment by guide: 30 marks
Interim presentation: 20 marks
Final Presentation and report: (20+30) = 50 marks