G. VENKATASWAMY NAIDU COLLEGE (AUTONOMOUS),
(Re-Accredited with 'A' grade by NAAC| DBT Star College Scheme)
(Affiliated to M.S. University, Tirunelveli)
KOVILPATTI – 628 502.

Department of BOTANY

BACHELOR OF SCIENCE

BOARD OF STUDIES

for the candidates admitted from the Academic Year 2023-2024 and onwards

Under CBCS PATTERN

DEPARTMENT OF BOTANY

VISION

- Provision of knowledge to contribute towards the sustainable utilization of Plant Biosphere.

MISSION

- To foster an environment of excellence by providing a comprehensive set of courses in plant sciences that enhances the understanding, depth of knowledge and technical competency of the students.
- To provide the competence skill to the students for entry-level research and teaching positions in biological sciences.
- To inculcate scientific vocabulary, reasoning skills and effective oral and written communication abilities among the students.
- To create a holistic understanding of the allied subjects through interdisciplinary approach.

PROGRAMME OUTCOMES

PO1 Disciplinary Knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study.

PO2 Critical Thinking: Capability to apply, knowledge; to analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach.

PO3 Problem Solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real-life situations.

PO4 Analytical Reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing view points.

PO5 Scientific Reasoning: Ability to analyse, interpret and draw conclusions from quantitative / qualitative data; and critically evaluate ideas, evidence, and experiences from an open-minded and reasoned perspective.

PO6 Self-directed & Lifelong Learning: Ability to work independently, identify and manage a project. Ability to acquire knowledge and skills, including "learning how to learn", through self- placed and self-directed learning aimed at personal development, meeting economic, social and cultural objectives.

PO7 Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team which can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1 Students will pursue the study of the biological concepts, appreciate the diversity in biology and kindle interest towards the creative and innovative ideas in Life Sciences.

PEO2 Students will understand and gain the knowledge of basic plant biology and study its relevant applications.

PEO3 Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology.

PROGRAMME SPECIFIC OUTCOMES

PSO1 Implement the concept of science and technology to foster the traditional and modern techniques for solving the complex problems in Plant Biology and understanding the scope and significance of Botany.

PSO2 Develop the scientific problem solving skills during experimentation, research projects, analysis, interpretation of data and generate useful information that address is various issues in Botany.

PSO3 Enhanced capacity to think critically; ability to design and execute experiments independently and/or team under multidisciplinary settings.

GRADUATE ATTRIBUTES

1) **Expertise in Practical Botany:** Clear, comprehensive, Skill in practical work, experiments, use of biological tool and techniques and advanced mastery in the field of Botany.
2) **Proficiency in Advanced Biological Technologies:** Understand Proficiency in the use of recent advanced biological technologies, advanced areas of biological sciences with special reference to Botany and its applied branches.
3) **Application of Knowledge for Self-Reliance:** Confidence to apply the acquired knowledge in practical life, ensure the implementation of a holistic pedagogical model in botany so as to make our country self-reliant.
4) **Development of Responsible Citizenship**: To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.
5) **Preparation for Competitive Examinations**: To enable the graduate to prepare for national level competitive Examinations, especially UGC-CSIR NET and UPSC Civil Services Examinations.
6) **Integration of Digital Skills in Biology:** The students would learn the use of the new technologies used in learning biology, digital platforms for fast transfer of information. Students will acquire digital skills and integrate the fundamental concepts with modern tools.

7) **Leadership and Managerial Skills**: The vast and deep knowledge of the subject, analytical and scientific reasoning, effective communication and problem solving task develop special qualities in a person to attract and influence the audience, which would be gained after the completion of this course. Students are expected to be familiar with decision making process and basic managerial skills to become a better leader.

PROGRAMME STRUCTURE FOR B.SC., BOTANY

(For those admitted from the academic year 2023-24 and onwards)

Category	Course Type	Course Code	Course Title	Contact Hours	Exam Hours	Marks			Credits
						CIA	ESE	Total Marks	
Semester-I									
PART-I	Language	U23TA1L1	Tamil– I	6	3	25	75	100	3
PART-II	English	U23EN1L1	English – I	6	3	25	75	100	3
PART-III	Core-1	U23BO101	Plant Diversity I – Algae	5	3	25	75	100	5
	Core-2 (Core Lab 1)	U23BO1P1	Plant Diversity I Algae	3	3	40	60	100	3
	Elective Generic-1 (Allied)	U23ZO1A1	Animal Diversity-I&II	4	3	25	75	100	3
	Elective Generic Lab-1 (Allied Lab)	U23ZO1AP	Animal Diversity-I&II lab	2	3	40	60	100	1
PART-IV	Skill Enhancement Course SEC1 (NME – 1)	U23BO1S1A	Organic farming	2	-	50	-	50	2
		U23BO1S1B	Environmental Biotechnology						
		U23BO1S1C	Nursery and Landscaping						
	Foundation Course FC	U23BOFC1	Basics of Botany	2	-	50	-	50	2
TOTAL				**30**				**700**	**22**
Semester-II									
PART-I	Language	U23TA2L2	Tamil– II	6	3	25	75	100	3
PART-II	English	U23EN2L2	English – II	6	3	25	75	100	3
PART-III	Core-3	U23BO202	Plant Diversity II – Fungi, Bacteria, Viruses, Plant pathology and Lichens	5	3	25	75	100	5
	Core-4 (Core Lab 2)	U23BO2P2	Fungi, Bacteria, Viruses, pathology	3	3	40	60	100	3

			and Lichens – Practical II						
	Elective Generic-2 (Allied)	U23ZO2A2	Human Physiology, Embryology, Immunology, Human Genetics and Animal Behaviour	4	3	25	75	100	3
	Elective Generic lab -2 (Allied Lab)	U21ZO2AP	Human Physiology, Embryology, Immunology, Human Genetics and Animal Behaviour	2	3	40	60	100	1
	Comprehension - 1(Self Study Course-Online Exam)	U23BO2C1	Comprehension in Botany – I	-	1	-	50	50	1
PART-IV	Skill Enhancement Course SEC-2 (NME – 2)	U23BO2S2A	Mushroom cultivation	2	-	50	-	50	2
		U23BO2S2B	Herbal Medicine						
		U23BO2S2C	Global climate change						
	Skill Enhancement Course (DSC) SEC3	U23BO2S3	Botanical garden and landscaping	2	2	-	50	50	2
TOTAL				**30**				**750**	**23**
Semester-III									
PART-I	Language	U23TA3L3	Tamil– III	6	3	25	75	100	3
PART-II	English	U23EN3L3	English – III	6	3	25	75	100	3
PART - III	Core-5	U23BO303	Plant Diversity III - Bryophytes and Pteridophytes	5	3	25	75	100	5
	Core-6 (Core Lab 3)	U23BO3P3	Plant Diversity III Bryophytes and Pteridophytes – Practical-III	3	3	40	60	100	3
	Elective	U23CH3AB3	Chemistry for	4	3	25	75	100	3

	Generic-3 (Allied)		Biological Sciences-I						
	Elective Generic lab – 3 (Allied Lab)	U23CH3AP	Chemistry practical for Physical and Biological Sciences-I (Volumetric analysis)	2	3	40	60	100	1
PART-IV	Skill Enhancement Courses (DSC) SEC 4	U23BO3S4	Entrepreneurial opportunities in Botany	2	2	50		50	2
	Ability Enhancement Compulsory Course – I	U23AE301	Environmental Studies	2	-	50	-	50	2
			TOTAL	**30**				**700**	**22**
Semester-IV									
PART-I	Language	U23TA4L4	Tamil– IV	6	3	25	75	100	3
PART-II	English	U23EN4L4	English – IV	6	3	25	75	100	3
PART - III	Core-7	U23BO404	Plant Diversity IV - Gymnosperms, Paleobotany and Evolution	4	3	25	75	100	4
	Core-8 (Core Lab 4)	U23BO4P4	Plant Diversity IV - Gymnosperms, Paleobotany and Evolution – Practical-IV	2	3	40	60	100	2
	Elective Generic – 4 (Allied)	U23CH4AB4	Chemistry for Biological Sciences II	4	3	25	75	100	3
	Elective Generic lab – (Allied Lab)	U23CH4AP	Chemistry Practical for Physical and Biological	2	3	40	60	100	1

			Sciences II						
	Elective Course – Industry Module	U23BO4IM	Cultivation of Algae	2	2	-	50	50	2
	Comprehension -II (Self Study Course-Online Exam)	U23BO4C2	Comprehension in Botany – II	-	1	-	50	50	1
PART-IV	Skill Enhancement Course (DSC) SEC 5	U23BO4S5	Fermentation Technology	2	2	-	50	50	2
	Ability Enhancement Compulsory Course –II	U23AE402	Yoga and value Education	2	-	50	-	50	2
	Internship/ Institutional Training/ Mini project **(**Carried out during Second Year Summer Vacation)	U23BO5IT	Internship/ Institutional Training/Mini Project	-	-	-		-	Completion
TOTAL				**30**				**800**	**23**
Semester-V									
PART - III	Core -9	U23BO505	Plant Morphology, Taxonomy and Economic Botany	5	3	25	75	100	5
	Core- 10	U23BO506	Plant Anatomy and Embryology	5	3	25	75	100	4
	Core – 11	U23BO5P5	Plant	4	3	40	60	100	3

	(Core Lab 5)		Morphology, Taxonomy And Economic Botany and plant Anatomy and Embryology						
	Core Elective-1	U23BO5E1A	Bio-Analytical Techniques	5	3	25	75	100	3
		U23BO5E1B	Aquatic Botany						
		U23BO5E1C	Entrepreneurial Botany						
	Core Elective-2	U23BO5E2A	Genetics and Plant Breeding	5	3	25	75	100	3
		U23BO5E2B	Biostatistics, Computer Application and Bioinformatics						
		U23BO5E2C	Industrial Microbiology						
	Major Project	U23BO5MP	Major group Project with Viva-voce	6	3	40	60	100	5
Part IV	Internship /Industrial training/Mini Project	U23BO5IT	Internship /Industrial training/Mini Project	-	-	40	60	100	2
	(Self-Study Courses) Proficiency Enhancement Course	U23GS5SS	General Studies			-	-	Completion	2
		MOOC/Spoken Tutorial (Self Study Course - online)		-	-	-	-	Completion	2
TOTAL				**30**				**700**	**29**

Semester-VI									
PART - III	Core -12	U23BO607	Plant Ecology and Phytogeography	6	3	25	75	100	5
	Core -13	U23BO608	Plant Biotechnology and Molecular Biology	5	3	25	75	100	5
	Core -14	U23BO609	Plant Physiology and Plant Biochemistry	5	3	25	75	100	5
	Core -15 (Core Lab 6)	U23BO6P6	Plant Ecology & Phytogeography Plant, Biotechnology & Molecular Biology, Plant Physiology and Plant Biochemistry	4	3	40	60	100	3
	Core Elective - 3	U23BO6E3A	Horticulture	4	3	25	75	100	3
		U23BO6E3B	Natural Resource Management						
		U23BO6E3C	Forestry						
	Core Elective-4	U23BO6E4A	Bionanotechnology	4	3	25	75	100	3
		U23BO6E4B	Computer application in Botany						
		U23BO6E4C	Forensic Botany						
	Comprehension - 3 (Self Study Course-Online Exam	U23BO6C3	Comprehension in Botany – III	-	1	-	50	50	1
Part IV	Professional	U23BO6S6	Training for	2	2		50	50	2

	Competency Skill SEC-6		Competitive examinations • Botany for Competitive examination • General Studies for Competitive examination • Botany for Advanced Studies						
	Extra Department Course Open Elective – (Self Study Course)	To be selected from the Courses offered by other departments		-	3	-	100	100	3
Part V	Extension Activities – NSS /YRC/ Physical Education			-	-	-	-	-	1
	NCC*								
TOTAL				**30**				**800**	**31**
Total Marks/Credit								**4450**	**150**

NCC * As per UGC norms, those students who opt NCC under extension activities will be studying the prescribed syllabi of the UGC which will include Theory, Practical and camp components. Such students who qualify the prescribed requirements will earn an additional **24 credits.**

Part-III B.Sc. Botany / Semester – III

Core-5: PLANT DIVERSITY-III BRYOPHYTES AND PTERIDOPHYTES (U23BO303)

Lecture Hours	**: 70**	**Tutorial Hours**	**: 5**
Practical Hours	**: -**	**No. of Credits**	**: 5**
Contact Hours per Semester: 75			
Contact hours per Week	**: 5**		
Internal Marks	**: 25**		
External Marks	**: 75**		
Total Marks	**: 100**		

Objectives of the Course

- To become familiar with Non-Vascular plants and its importance.
- To acquire knowledge on structure, reproduction and lifecycle of specified Bryophytes.
- To gain knowledge on classification and general features of Pteridophytes.
- To understand the structure, reproduction and life cycle of specified Pterodophytes.
- To learn about the stellar evolution and economic importance of Pterodophytes.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the Course, the students will be able to

CO1 characterize the features, structures, classification and distribution of bryophytes.

CO2 understand the structure, reproduction and life cycle of the following classes each with a suitable example: Hepaticopsida (*Marchantia*); Anthoceropsida (*Anthoceros*) and Bryopsida (*Funaria*).

CO3 classify and know about general features of Pterodophytes.

CO4 identify the occurrence, structure, reproduction and life cycle of *Psilotum*, *Lycopodium*, *Equisetum* and *Adiantum* .

CO5 understand stelar evolution and economic importance of Pteridophytes.

CO-PO AND PSO MAPPING (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	3	2	3	2	2
CO 2	3	3	2	2	2	3	2	3	2	2
CO 3	3	3	2	2	3	3	2	3	2	2
CO 4	3	3	2	2	1	3	3	3	2	2
CO 5	3	2	2	2	2	3	2	3	2	2
Total Contribution of COs to POs	15	14	10	10	11	15	11	15	10	10
Weighted Percentage of COs contribution to POs	100	93	67	67	73	100	73	100	67	67

0-No Correlation **1-Weak** **2-Moderate** **3-Strong**

Course Content

Unit I Bryophytes (L – 14 hrs; T-1 hr)

General characters of Bryophytes, classification (Rothmaler, 1951) (up to order level). Economic importance of Bryophytes – Medicinal uses, horticulture, industrial uses. Ecological importance (Pollution indicators and monitoring).

Unit II Bryophytes (L – 14 hrs; T-1 hr)

Structure, reproduction and life cycle of the following classes each with a suitable example: Hepaticopsida (*Marchantia*); Anthocerotopsida (*Anthoceros*) and Bryopsida (*Funaria*).

Unit III Pteridophytes (L – 14 hrs; T-1 hr)

General Characters of Pteridophytes . Classification (Sporne, 1966). Apogamy and Apospory, Homospory and Heterospory.

Unit IV Pteridophytes (L – 14 hrs; T-1 hr)

Morphology, anatomy and reproduction of the taxa belonging to each of the following classes: Psilotopsida (*Psilotum*), Lycopsida (*Lycopodium*), Sphenopsida (*Equisetum*), Pteropsida (*Adiantum).*

Unit V Pteridophytes (L – 14 hrs;T-1 hr)

Stelar Evolution and its types. Economic importance of Pteridophytes- Ecological importance- Food, Fiber, Handicraft, Horticulture, Biofertilizer, Medicines , pollution indicator.

Recommended Text

1. Chopra, R. N. *Biology of bryophytes*. New Age International (P) Ltd. New Delhi, India. 2005.

2. Pandey, B.P. *College Botany* – Vol. II, S.Chand and Company Ltd., New Delhi. 2004.
3. Rashid, A.. *An Introduction to Pteridophytes*, Vikas Publishing House Pvt., Ltd, NewDelhi. 2007.
4. Sharma, O.P. *Bryophyta*, MacMillan India Ltd. Delhi. 2017.
5. Singh, V, P. C. Pande and D. K. Jain. *Text Book of Botany*, Rastogi publications (5thed.), U. P, India. 2019.

Reference Books

1. Eames, A. *Morphology of lower vascular plant*, McGraw Hill, Chennai. 1963.
2. Parihar, N.S. *Bryophytes*. Central Book Depot, Allahabad. 1991.
3. Sporne, K.L. *Morphology of Pteridophytes*, 4th edition, B.I. Publication. Chennai. 1976.
4. Vashishta, B.R. *Botany for degree students – Pteridophytes*, Chand and Co., NewDelhi. 1976.
5. Watson, E.V. *The structure and Life of Bryophytes*. Hutchinson & Co, UK. 1963.

Website and E-learning Sources

1. https://archive.org/details/in.ernet.dli.2015.550853/page/n9/mode/2up
2. http://www.bryoecol.mtu.edu/
3. http://scitec.uwichill.edu.bb/bcs/bl14apl/bryo1.htm
4. http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx
5. http://www.botany.ubc.ca/bryophyte/mossintro.html

Part-III B.Sc. Botany / Semester – III

Core-6: PLANT DIVERSITY III BRYOPHYTES AND PTERIDOPHYTES – PRACTICAL-III (U23BO3P3)

Lecture Hours	**: -**	**Tutorial Hours**	**: -**
Practical Hours	**: 3**	**No. of Credits**	**: 3**
Contact Hours per Semester: 45			
Contact hours per Week	**: 3**		
Internal Marks	**: 40**		
External Marks	**: 60**		
Total Marks	**: 100**		

Objectives of the Course

- To recognize the vegetative and reproductive structures of Hepaticopsida.
- To recognize the vegetative and reproductive structures of Hepaticopsida.
- To identify the vegetative and reproductive structures of Anthocerotopsida and Mosses.
- To understand the morphological and reproductive feature of Psilotum and Lycopodium.
- To develop the skill of micro-preparation of fresh and preserved specimens.
- To gain knowledge on external and internal features of Equisetum, Identify Bryophytes and Pteridophytes in field.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the Course, the students will be able to

CO1 understand the morphology, anatomical and reproductive structures of *Marchantia.*

CO2 understand and relate the morphology, anatomical and reproductive structures of *Anthoceros* and *Funaria.*

CO3 analyse the morphology, anatomical and reproductive structures of *Psilotum* and *Lycopodium*

CO4 comprehend the morphological, anatomical and reproductive features of *Adiantum.*

CO5 recognize the external and internal features of *Equisetum* and identify Bryophytes and Pteridophytes in field.

CO-PO AND PSO MAPPING (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2	3	2	1	2	3	3	3	3
CO 2	2	2	2	2	2	2	3	3	3	3
CO 3	2	2	1	2	2	2	3	3	3	3
CO 4	2	2	3	2	3	2	3	3	3	3
CO 5	2	1	2	1	2	2	3	2	2	2
Total Contribution of COs to POs	10	9	11	9	10	10	15	14	14	14
Weighted Percentage of COs contribution to POs	67	60	73	60	67	67	100	93	93	93

0-No Correlation **1-Weak** **2-Moderate** **3-Strong**

Course Content

Unit I Internal structure of *Marchantia* (P-9 hrs)

Marchantia- Habit, T.S of Marchantia thallus, T.S of Gemma cup, Longitudinal section of Antheridiophore, L.S of Archegoniophore, L.S of sporophyte.

Unit II Internal structure of *Anthoceros* (P-9 hrs)

Anthoceros- Habit, T.S of Anthoceros thallus, mature antheridium, mature archegonium, L.S of sporophyte. *Funaria*- Habit, T.S of stem, L.S of Antheridial, L.S of Archegonial, L.S of sporophyte.

Unit III Internal structure of *Psilotum* (P-9 hrs)

Psilotum- Habit, T.S of rhizome, Internal structure of aerial axis and Cross sectionand Longitudinal section of Synangium. *Lycopodium*- Habit, T.S of root, Internal structure of stem, Vertical section of cone, structure of sporangium.

Unit IV Internal structure of *Adiantum* (P-9 hrs)

Adiantum- Habit, T. S of rhizoids, T.S. of petiole, T.S. of root, Vertical section of sporophyll with sporangium.

Unit V Internal structure of *Equisetum* (P-9 hrs)

Equisetum: Permanent slides observation : T.S. of Stem (Node and Internode), T.S of Root, L.S. of Cone, T.S. of Cone.

Botanical excursion for one day. - Collection of Bryophytes and Pteridophytes.

Recommended Text

1. Ashok, M. Bendre and Kumar. *A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany*. Revised ed. Rastogi publication., Meerut, India. 2010.

2. Pandey, B.P. *College Botany* – Vol. II, S. Chand and Company Ltd., New Delhi.
3. Parihar, N.S. (1987). *The Biology and Morphology of Pteridophytes*, Central Book Distributors, Allahabad. 2004.
4. Suresh kumar. *Manual of practical Bryophyta*. Premium paper back. ISBN-10 : 8180300374
5. Sharma, O.P., 2014. *Series and diversity of Bryophyta*. Mc Graw Hill education India Private Ltd, New Delhi. 2012.

Reference Books

1. Mohammed Gufran Khan, Shite Gatew and Bedilu Bekele. *Practical manual for Bryophytes and Pteridophytes.* Lambert Academic Publishing. 2012
2. Rashid, A. *An introduction to Pteridophyta* – Diversity, Development and Differentiation (2nd ed.), New Delhi. 2013.
3. Smith, G.M. *Cryptogamic Botany. Vol.* II, Tata McGraw Hill Publishing Co. Ltd. New Delhi. (1955).

Website and E-learning Sources

1. https://www.easybiologyclass.com/classification-of-gymnosperms-by-sporne-short-notes/
2. https://www.britannica.com/plant/plant/Evolution-and-paleobotany
3. https://indiabiodiversity.org

Part-IV B.Sc. Botany / Semester – III

SKILL ENHANCEMENT COURSES

ENTREPRENEURIAL SKILL ENTREPRENEURIAL OPPORTUNITIES IN BOTANY (U23BO3S4)

Lecture Hours	**: 30**	**Tutorial Hours**	**: 0**
Practical Hours	**: -**	**No. of Credits**	**: 2**
Contact Hours per Semester: 30			
Contact hours per Week	**: 2**		
Internal Marks	**: 50**		
External Marks	**: -**		
Total Marks	**: 50**		

Objectives of the Course

- To understand the concept of Entrepreneurial Opportunities in Botany.
- To enable students to understand about establishment of various ventures after graduates in Botany using medicinal plants, Biotechniques and marketing of Bioproducts.
- To create a mindset among students to start their own companies for income generation.
- To understand about various fields of botany.
- To develop the concept of Entrepreneurial Opportunities in Botany.
- To describe marketing and business management strategy.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the Course, the students will be able to

CO1 relate to how various fields of botany could be understood with an entrepreneurial approach.

CO2 explain the concept of Entrepreneurial Opportunities in Botany.

CO3 make use of the knowledge gained to start new venture using Plant tissue culture and plant products for commercial exploitations.

CO4 decipher effective ways of making Bioproducts like organic acids, solvents, beverages, enzymes, antibiotics, mushrooms, biogas and etc.

CO5 develop new strategies to describe marketing and business management strategy including the role of IPR and bioethics regulations for licensing.

CO-PO AND PSO MAPPING (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	3	3	3	3
CO 2	3	3	3	3	3	2	3	3	3	3
CO 3	2	3	3	3	3	3	2	1	3	3
CO 4	3	3	2	3	3	2	2	3	3	2
CO 5	3	3	2	2	2	2	2	2	2	1
Total Contribution of COs to POs	14	15	13	14	14	11	12	12	14	12
Weighted Percentage of COs contribution to POs	93	100	87	93	93	73	80	80	93	80

0-No Correlation **1-Weak** **2-Moderate** **3-Strong**

Course Content

Unit I Introduction to Entrepreneurship (L-6 hrs)

Introduction to Entrepreneurship, Scope and identification of new ventures using plant resources, Mechanism of product selection and commercialization, General concept about the Govt. formalities, rules & regulation, Entrepreneurship skill development.

Unit II Tools and Techniques (L-6 hrs)

Production of commercially viable plants through Plant tissue culture technique, Production of secondary metabolites, solvents, organic acids, beverages, enzymes, antibiotics.

Unit III New Venture Creation (L-6 hrs)

Production of Biofertilizers, Vermicompost, Establishment of medicinal, herbal and zodiac gardens, Terrace & Kitchen garden, *Spirulina* and *Azolla* cultivation, Mushroom cultivation, Bonsai, Bouquet making, Terrarium.

Unit IV Product Development and Commercialization (L-6 hrs)

Product commercialization and business strategy, Dyes, Cosmetics and Perfumes, Gums, Resins & Latex, Areca Leaf Plates, cups & bags, Jute Products.

Unit V Bio-Business Plans, Ipr and Bioethics (L-6 hrs)

Marketing and Business management strategy, Bank loan, Marketing and public perceptions in product development – Technology licensing and branding concerns. Intellectual property rights, Patent laws - Bioethics and current legal issues,

Recommended Text

1. Gurinder Shahi. *Bio-Business in Asia*: How countries Can Capitalize on the Life Science Revolution, Pearson Prentice Hall, New Delhi, India. 2004.

2. Karthikeyan, S. and Arthur Ruf. *Biobusiness*, MJP Publications. Chennai, India. 2009.

3. Richard Oliver. *The coming Biotech age*: The Business of Biomaterials, McGraw Hill Publications, New York, USA. . 2000.

4. Adams, C.R. Banford, K.M. and Early, M.P. *Principles of Horticulture*. 1993.

5. Sathe,T.V. *Vermiculture and Organic farming*, Daya Publishers. 2004.

Reference books

1. Robin Lowe and Sue Marriott. Enterprise: *Entrepreneurship and Innovation: Concepts, Contexts and Commercialization*, Routledge Publisher, London, UK. 2009.
2. Peter F.Drucker, *Innovation and Entrepreneurship*, Harper Collins Publisher, New York, US. 2009.
3. Russell, T. Nature Guide: Trees: *The world in your hands* (Nature Guides). Mukherjee D. Gardening in India, Oxford IBH publishing co, New Delhi. 2012.
4. Kumar, N. *Introduction to Horticulture*, Rajalakshmi Publications, Nagercoil. 1997.
5. Webster, J and Weber, R. *Introduction to Fungi*, 3rd Ed. Cambridge University Press, Cambridge. 2007.

Website and E-learning Sources

1. https://www.brainkart.com/article/Entrepreneurial-Botany_38321/
2. https://www.youtube.com/watch?v=hnBla1FfcLo
3. https://www.slideshare.net/krishnashah5891004/ram-power-point-presentation
4. http://www.brainkart.com/article/Economically-Useful-Plants-andEntrepreneurial-Botany_38301
5. https://www.ebooks.com/en-us/subjects/gardening/
6. https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition-ebook/dp/B00RXCXB3Q

Part-III B.Sc. Botany / Semester – IV

Core-7: PLANT DIVERSITY IV - GYMNOSPERMS, PALEOBOTANY AND EVOLUTION (U23BO404)

Lecture Hours	**: 55**	**Tutorial Hours**	**: 5**
Practical Hours	**: -**	**No. of Credits**	**: 5**
Contact Hours per Semester: 60			
Contact hours per Week	**: 4**		
Internal Marks	**: 25**		
External Marks	**: 75**		
Total Marks	**: 100**		

Objectives of the Course

- To impart Knowledge on the characteristics of Gymnosperms.
- To understand the Morphology, anatomy and reproduction of taxa belonging to each order.
- To acquire basic knowledge of Paleobotany.
- To gain knowledge on specified fossil plants.
- To acquire knowledge on evolution.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the Course, the students will be able to

CO1 understand the features, structure, classification and reproduction of Gymnosperms.

CO2 gain knowledge on the morphology, anatomy and reproduction of *Pinus* and *Gnetum.*

CO3 analyze about the fossil and method of fossilization.

CO4 comprehend on specified fossil plants.

CO5 understand and appreciate the process of origin of life and evolution.

CO-PO AND PSO MAPPING (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	2	3	2	1
CO 2	3	2	3	2	2	2	2	3	2	2
CO 3	3	2	2	2	2	1	2	3	2	3
CO 4	3	2	2	3	3	3	2	3	2	1
CO 5	3	2	1	2	2	2	2	3	3	3
Total Contribution of COs to POs	15	10	10	12	12	10	10	15	11	10
Weighted Percentage of COs contribution to POs	100	67	67	80	80	67	67	100	73	67

0-No Correlation **1-Weak** **2-Moderate** **3-Strong**

Course Content

Unit I Gymnosperms (L-11 hrs; T-1 hrs)

General characters, Classification of Gymnosperms (Sporne, 1954) (up to family)., Morphology, anatomy and reproduction of Cycadales (*Cycas*),

Unit II Anatomy and reproduction of Gymnosperms (L-11 hrs;T-1 hrs)

Morphology, anatomy and reproduction of Coniferales (*Pinus*) and Gnetales (*Gnetum*). Economic importance of Gymnosperms with special reference to ornamental value ,oil, resin, timber and medicine.

Unit III Paleobotany (L-11 hrs; T-1 hrs)

Introduction to fossils, fossilization processes - compression, casts, molds, petrification, impressions and coal balls. Geological time scale. Radiocarbon dating. Contribution of Birbal Sahni

Unit IV Fossils (L-11 hrs;T-1 hrs)

Study of the following fossils: *Rhynia, Lepidodendron, Lepidocarpon*, *Calamites* and *Williamsonia sewardiana*.

Unit V Evolution and Co-evolution (L-11 hrs;T-1 hrs)

Evolution - origin of life (Any five theories). Darwin - Natural selection, modern synthetic theory. Variation - analysis and sources, adaptive radiation, Concept of speciation - Allopatric and sympatric.

Recommended Text

1. Anil Kumar. *Gymnosperms*. S. Chand & Company Pvt. Ltd. New Delhi. 2006.
2. Arnold. *Introduction to Paleobotany*, Mc.Graw Hill Co., New York. 1977.
3. Arthurwart Lindsey. *Text book of Evolution and Genetics*. Mc Millan & Co, UK. 1992.

4. Bhatnagar, S.P and Moitra, A. *Gymnosperms. New Age*. International Publishers, New Delhi, India. 1996.
5. Gupta, M.N. *The Gymnosperms* (2nd Edition) Shiva Lal Agarwala & Co., Agra. 1972.
6. Vashista, P.C. *Gymnosperms*, S.Chand & Co. New Delhi. 1976.

Reference Books

1. Bhatnagar S.P and Alok Moitra. *Gymnosperms*. Publisher: New Age International Pvt Ltd Publishers. New Delhi. 2013.
2. Bhatnagar, S.P and Moitra, A. *Gymnosperms*, New Age Int. Pvt. Ltd., New Delhi. 1996.
3. Raup, D.M and Steven, M. Stanley. *Principles of paleontology*. San Francisco: W.H. Freeman. 2004.
4. Sporne, K.R. *The Morphology of Gymnosperme*. B.I. Publications, New Delhi. 1991.
5. Stewart, W.N and Rathwell, G.W. *Paleobotany and the Evolution of Plants*. Cambridge University Press. 1993.

Website and E-learning Sources

1. http://www.grsmu.by/files/file/university/cafedry/microbiologii-virysologii-immynologii/files/essential_microbiology.pdf
2. https://rlmc.edu.pk/themes/images/gallery/library/books/Microbiology/Text_Book_of_Microbiology.pdf
3. https://drive.google.com/file/d/1702Db5Ct6iYZ4EY6wj9O_KgdRM-Y1ink/view
4. https://content.kopykitab.com/ebooks/2016/07/8082/sample/sample_8082.pdf
5. https://biologywala.com/microbiology-an-introduction-book-pdf13th-edi/

Part-III B.Sc. Botany / Semester – IV

Core-8: (Core Lab 4) PLANT DIVERSITY IV - GYMNOSPERMS, PALEOBOTANY AND EVOLUTION – PRACTICAL-IV (U23BO4P4)

Lecture Hours	**: -**	**Tutorial Hours**	**: -**
Practical Hours	**: 2**	**No. of Credits**	**: 2**
Contact Hours per Semester: 30			
Contact hours per Week	**: 2**		
Internal Marks	**: 40**		
External Marks	**: 60**		
Total Marks	**: 100**		

Objectives of the Course

- To develop the skill of micro-preparation of fresh and preserved specimens and recognize the vegetative and reproductive structures of Cycas.
- To identify the vegetative and reproductive structures of Pinus.
- To understand the morphological and reproductive features of and *Gnetum.*
- To observe and understand the structure of fossil forms through slides and photograph .
- To gain knowledge on the contribution of evolution scientists.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the Course, the students will be able to

CO1 understand the morphology, anatomical and reproductive structures of *Cycas.*

CO2 gain knowledge on the morphology, anatomical and reproductive structures of *Pinus.*

CO3 relate the morphology, anatomical and reproductive structures of *Gnetum.*

CO4 analyze the structure of fossil forms.

CO5 appreciate the contribution of evolution scientists.

CO-PO AND PSO MAPPING (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2	1	2	3	2	2	3	3	3
CO 2	2	2	3	2	2	2	2	3	3	3
CO 3	2	2	2	2	1	2	2	3	3	3
CO 4	2	2	2	2	3	2	2	3	3	3
CO 5	2	1	2	1	2	2	2	2	2	2
Total Contribution of COs to POs	10	9	10	9	11	10	10	14	14	14
Weighted Percentage of COs contribution to POs	67	60	67	60	73	67	100	93	93	93

0-No Correlation **1-Weak** **2-Moderate** **3-Strong**

Course Content

Unit I Morphological and Anatomical Study of Cycas (P-9 hrs)

Cycas-Leafy twig, Sectioning- Leaf let, Rachis. Permanent slides- T.S of normal and coralloid root-Microsprophyll-T.S. Male cone –entire, abaxial and adaxial view of single microsporophyll, Megasporphyll, Ovule-Entire.

Unit II Morphological and Anatomical Study of Pinus (P-9 hrs)

Pinus- Leafy twig, sectioning,- Needle. Permanent slides- T.S of root, stem, L.S of Male cone. Male cone entire, Female cone entire- L.S of Ovule.

Unit III Morphological and Anatomical Study of Genturm (P-9 hrs)

Gnetum- Leafy twig, sectioning- Leaf and young stem. Permanent slides- T.S of young and old root, T.S of young and old stem, L.s of inflorescence- L.s of Ovule.

Unit IV Permanent Slides and Photographic Study of Ancient Plants (P-9 hrs)

Permanent slides/Photograph- *Rhynia, Lepidodendron, Lepidocarpon, Calamites and Williamsonia sewardiana.*

Unit V Evolutionary Studies and Field Exploration (P-9 hrs)

Photograph of evolutionist - Darwin, Field visit to Study the habitat of Gymnsoperms (Hill station).

Recommended Text

1. Bhatnagar, S.P and Moitra, A. *Gymnosperms. New Age* International Publishers, New Delhi, India. 1996.
2. Gangulee, H.C and A.K. Kar. *College Botany*. Vth Edition. S. Chand. 2013.
3. Sharma O.P and S, Dixit. *Gymnosperms*. Pragati Prakashan. 2002.

4. Vashista, P.C. *Gymnosperms*, S.Chand & Co. New Delhi. 1976.
5. Fossil Book to be add

Reference Books

1. James.W. Byng. *The Gymnosperms practical hand book*. A practical guide to extant families and genera of the world. Published by plant Gateway, Tol Bot Street, Herford, SG137BX, United Kingdom. 2015.
2. Kirkaldy, J.E. *The study of Fossils.* Hutchinson Educational, London. 1963.
3. Sharma, O.P. *Textbook of Pteridophyta*, TATA MacMillan India Ltd., New Delhi. 2012.

Website and E-learning Sources

1. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gy mnosperms&printsec=frontcover
2. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721
3. https://books.google.co.in/books/about/Paleobotany.html?id=HzYUAQAAIAAJ
4. https://trove.nla.gov.au/work/11471742?q&versionId=46695996
5. http://www.freebookcentre.net/Biology/Evolutionary-Biology-Books.html.

Part-III B.Sc. Botany / Semester – IV

ELECTIVE COURSE – INDUSTRY MODULE - CULTIVATION OF ALGAE (U23BO4IM)

Lecture Hours	**: 30**	**Tutorial Hours**	**:**
Practical Hours	**: -**	**No. of Credit**	**: 2**

Contact Hours per Semester: 30

Contact hours per Week : 2

Internal Marks :

External Marks : 50

Total Marks : 50

Objectives of the Course

- To impart sufficient information about the culture and cultivation of algae under laboratory andoutdoor conditions.
- To study the media composition for algae cultivation and high value products and its applications.
- To know about the important seaweeds and its cultivation practices.
- To study the SLF production and applications in agriculture crops.
- To understand about the Environment Impact Assessment of algal cultivation.

Course Learning Outcomes

On completion of the Course, the students will be able to

CO1 obtain an in-depth knowledge on culture and mass cultivation of algae and its different methods.

CO2 explore and recommend the commercial potential of algal products.

CO3 understand the applied facet of algology and acquire a complete knowledge about the cultivation methods in algae.

CO4 describe the preparation of seaweed liquid fertilizers and their applications in agricultureand horticulture.

CO5 acquire the information about algal applications in different industries and agriculture fields in the current scenario.

CO-PO AND PSO MAPPING (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	3	2	1	2	2
CO 2	3	2	1	2	3	2	2	3	2	3
CO 3	2	1	1	3	2	3	2	1	2	3
CO 4	3	3	3	3	1	2	2	2	1	3
CO 5	3	3	2	2	2	1	2	1	3	3
Total Contribution of COs to POs	14	11	8	13	10	11	10	8	10	14
Weighted Percentage of COs contribution to POs	93	73	53	87	67	73	67	53	67	93

0-No Correlation **1-Weak** **2-Moderate** **3-Strong**

Course Content

Unit I Morphology, Life History, and Mass Culture of Microalgae (L-6 hrs)

Morphology, life history and mass culture of microalgae: *Spirulina*, *Chlorella*, *Dunaliella* and *Botryococcus.*

Unit II Value Products from Algae (L-6 hrs)

High value products: Single Cell Protein (SCP), phycocyanin, β-carotene, astaxanthin –biofuel, media composition - scale up - lab to land - raceway ponds and photobioreactor.

Unit III Marine Microalgae (L-6 hrs)

Marine macroalgae: Morphology, life history and mass cultivation of *Gracilaria*, *Kappaphycus*, *Sargassum* and *Ulva.*

Unit IV Polysaccharides (L-6 hrs)

Polysaccharides: agar, carrageen, alginate - economic importance - seaweed as food, feed and Seaweed Liquid Fertilizer (SLF), Algal bioprospecting.

Unit V Seaweeds in aquaculture (L-6 hrs)

Role of seaweeds in aquaculture: Environment Impact Assessment of algal cultivation. (Demostration).

Recommended Text

1. Kumar H.D. and Singh, H.N. *A Text Book of Algae* Affiliated East West Press Pvt. Ltd., New Delhi, Madras. 1976.

2. Kumar, H.D. *Introductory Phycology*, Affiliated East West Press (P) Ltd., New Delhi, Madras, Hyderabad, Bangalore. 1990.
3. Pandey, B.P. *A Text book of Botany-Algae* S. Chand & Co., (P) Ltd., New Delhi. 1993.
4. Sharma, O.P. *Text Book of Algae* Tata McGraw Hill Publishing Co., Ltd., New Delhi. 1990.
5. Vashista, B.R. *Botany for degree students-Algae*. S. Chand & Co., (P) Ltd., New Delhi. 1988.

Reference Book

1. Bilgrami, K.S., and L.C. Saha. *A Text Book of Algae*, CBS Publishers & Distributors (P)Ltd., New Delhi. 1996.
2. Chapman, V.J. and Chapman, D.J. *The Algae. 2nd Ed*. ELBS & MacMillan, 498 pp. 1973.
3. Fritsch F.E. *The Structure and Reproduction of Algae* 1945. Cambridge University Press, Cambridge, U.K. Vol. I-791 pp., Vol. II-939 pp. 1935.
4. Round, F.E. *Biology of the Algae. 2nd Ed*. Edward Arnold, London. 278 pp. 1973
5. Sharma, O.P. *Text Book of Algae*. Tata McGraw Hill Publishing Co., Ltd., New Delhi. 1990.

Website and E-learning Sources

1. https://www.aiche.org/academy/videos/conference-presentations/study-culture-strategies-microalgae-continuous-photobioreactor-system-biofuel-production
2. https://link.springer.com/article/10.1007/s10811-013-9983-9
3. https://www.nrel.gov/docs/legosti/old/2360.pdf
4. file:///C:/Users/Lenovo/AppData/Local/Temp/alba2018.pdf
5. file:///C:/Users/Lenovo/AppData/Local/Temp/Seaweed_aquaculture_Cultivation_technologies_chall.pdf

Part-IV B.Sc. Botany / Semester – IV

SKILL ENHANCEMENT COURSE/SEC-5 - FERMENTATION TECHNOLOGY (U23BO4S5)

Lecture Hours	**: 30**	**Tutorial Hours**	**:**
Practical Hours	**: -**	**No. of Credits**	**: 2**

Contact Hours per Semester: 30

Contact hours per Week : 2

Internal Marks :

External Marks : 50

Total Marks : 50

Objectives of the Course

- To appreciate the significance of microbes synthesizing fermented products.
- To gain insights on safety and quality control in large scale production of fermentative products.
- To design and operation of industrial practices in mass production of fermented products.
- To know about the various fermentation technology.
- To learn about the bioproduct recovery.

Course Learning Outcomes

On completion of the Course, the students will be able to

CO1 enumerate the significance of industrially useful microbes.

CO2 explain the design and operation of industrial practices in mass production of fermented products.

CO3 explain the process of maintenance and preservation of microorganisms.

CO4 analyze the various aspects of the fermentation technology and apply for fermentative production.

CO5 validate the experimental techniques for microbial production of enzymes: amylase and protease, bio products recover.

Mapping with Programme Outcomes: (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	3	3	3	2	2
CO 2	3	3	2	2	2	1	2	2	3	2
CO 3	2	2	3	2	1	2	2	3	2	3
CO 4	3	3	2	1	3	2	3	2	1	3
CO 5	3	3	2	3	2	3	1	3	3	3
Total Contribution of COs to POs	14	13	10	11	10	11	11	13	11	10
Weighted Percentage of COs contribution to POs	93	87	67	73	67	73	73	87	73	67

0-No Correlation **1-Weak** **2-Moderate** **3-Strong**

Course Content

Unit I Scope and Opportunities of Fermentation Technology (L-6 hrs)

Scope and opportunities of fermentation technology. Principles of fermentation: Submerged, solid state, batch, fed-batch and continuous culture.

Unit II Microbial Culture Preparation (L-6 hrs)

Preparation of microbial culture, Preparation and sterilization of fermentation media. Isolation and improvement of industrially important microorganisms.

Unit III Microbial Maintenance (L-6 hrs)

Maintenance and preservation of microorganisms, Metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.

Unit IV Fermentative productions (L-6 hrs)

Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin).

Unit V Mircobial production (L-6 hrs)

Microbial production of enzymes: Amylase and Protease. Bioproduct recovery.

Recommended Text

1. Waites M.J. *Industrial Microbiology*: *An Introduction*, 7th Edition, Blackwell Science, London, UK. 2008.
2. Prescott S.C., Dunn C.G., Reed G. *Prescott & Dunn's Industrial Microbiology,* 4th Edition, AVI Pub. Co., USA. 1982.
3. Reed G. *Prescott & Dunn's industrial microbiology*, 4th Edition, AVI Pub. Co., USA. 2004.

4. JR Casida L.E. *Industrial Microbiology*, 3rd Edition, New Age International (P) Limited Publishers, New Delhi, India. 2015.
5. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. *Industrial Microbiology*: An Introduction. 1st Edition, Blackwell Science, London, UK. 2001.
6. Pelczar M.J., Chan E.C.S. and Krieg N.R. *Microbiology*. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi. 2003.

Reference Books

1. Peter F Stanbury, Allan Whitaker, Stephen J Hall. *Principles of Fermentation Technology*. Butterworth-Heinemann Press. UK. 2016.

2. Peppler, H. J. D. Perlman. *Microbial Technology: Fermentation Technology*. Academic Press. 2014.

3. T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. *Fermentation Microbiology and Biotechnology*. Second Edition. 2006. CRC Press, USA.

4. Hongzhang Chen. *Modern Solid State Fermentation: Theory and Practice*. Springer Press, Germany. 2013.

5. John E. Smith. *Biotechnology*. Cambridge University Press.UK. 2009.

6. Celeste M. Todaro, Henry C. Vogel. *Fermentation and Biochemical Engineering Handbook*. William Andrew Press. Norwich, NY. 2014.

7. Lancini, G. R. Lorenzetti. *Biotechnology of Antibiotics and other Bioactive Microbial Metabolites.* Springer publications, Germany. 2014.

Website and E-learning Sources

1. https://ebooks.foodtechlearning.xyz/2020/12/principal-of-fermentation-technology-by.html
2. https://www.amazon.in/Principles-Fermentation-Technology-Peter-Stanbury-ebook/dp/B01LMDYFNQ
3. https://www.amazon.in/Principles-Fermentation-Technology-Peter-Stanbury-ebook/dp/B01E3IC73W
4. https://www.pdfdrive.com/principles-of-fermentation-technology-e189052809.html
5. https://www.ebooks.com/en-us/book/2698294/principles-of-fermentation-technology/peter-f-stanbury/