

ST. JOSEPH'S COLLEGE (AUTONOMOUS)

BENGALURU-27



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

DEPARTMENT OF BOTANY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

(AS PER NEP 2021)

For Batch 2021 Onwards

Part A		
1	Title of the Academic Program	BSc Chemistry Botany and Zoology (CEB, MCB, CBBt, BZBc)
2	Program Code	SJC BSc CBZ etc (To be given by Examination Section)
3	Name of the College	St. Joseph's College (Autonomous)
4	Objective of the College	<ol style="list-style-type: none"> 1. Academic Excellence 2. Character Formation 3. Social Concern
5	Vision of the College	“Striving for a just, secular, democratic and economically sound society, which cares for the poor, the oppressed and the marginalized”
6	Mission of the College	M1 St. Joseph's College (Autonomous) seeks to form men and women who will be agents of change, committed to the creation of a society that is just, secular and democratic.
		M2 The education offered is oriented towards enabling students to strive for both academic and human excellence.
		M3 The college pursues academic excellence by providing a learning environment that constantly challenges the students and supports the ethical pursuit of intellectual curiosity and ceaseless enquiry.
		M4 Human excellence is promoted through courses and activities that help students achieve personal integrity and conscientize them to the injustice prevalent in society.
7	Name of the Degree	Bachelor of Science (B.Sc.,)
8	Name of the Department offering the program	Botany
9	Vision of the Department offering the program	“The Department intends to inculcate in the students an interest to explore the world of Botanical science and contribute to the rapidly expanding field. We wish to offer the society, a generation of humble yet aspiring young minds eagerly striving towards unraveling the mystery of Plants”
10	Mission of the department offering the Program	<ul style="list-style-type: none"> • The Department of Botany aim at identifying one's potential to become a centre for augmenting and contributing continuously to the vibrant field of plant sciences. • We strive to create and provide an ambient learning atmosphere and prepare students for academia, industry and productive application of the knowledge in everyday life. • It emphasizes the impact of plants on food, agriculture, environment and other human activities.
11	Duration of the Program	3 years (Six semesters)
12	Total No. of Credits	38
13	Program Educational Objectives (PEOs)	PEO1
		PEO2
		PEO3
<p>Programme Educational Objectives: PEOs are statements that describe Institution's Mission aligned with the programme (To be Prepared in consultation with other departments (Languages and Optional subjects) 2-5 PEOs can be written.</p> <ul style="list-style-type: none"> • Guidelines for the PEOs <ul style="list-style-type: none"> – PEOs should be consistent with the mission of the Institution 		

			<ul style="list-style-type: none"> - The number of PEOs should be manageable - PEOs should be achievable by the program - PEOs should be specific to the program and not too broad
14	Graduation Attributes		<p>The Following graduate attributes reflect the particular quality and feature or characteristics of an individual, that are expected to be acquired by a graduate through studies at St. Joseph's College.</p> <ul style="list-style-type: none"> • Disciplinary knowledge • Communication Skills • Critical thinking • Problem solving • Analytical reasoning • Research-related skills • Cooperation/Team work • Reflective thinking • Information/digital literacy • Self-directed learning and Lifelong learner • Multicultural competence • Moral and ethical awareness/reasoning • Leadership readiness/qualities • International Outlook
15	Program Outcomes (POs)	PO1	
		PO2	
		PO3	
		PO4	
<p>Programme Outcomes: POs are statements that describe what the students graduating from any of the educational Programmes should be able to do (To be Prepared in consultation with other departments) (Languages and Optional subjects. 4-10 POs can be written</p> <ul style="list-style-type: none"> • Guidelines for the POs <ul style="list-style-type: none"> - Program outcomes basically describe knowledge, skills and behavior of students as they progress through the program as well as by the time of graduation. - POs should not be too broad - They must be aligned with the Graduation Attributes 			
16	Program Specific Outcomes (PSOs)	PSO1	Acquired knowledge and understanding of the botanical sciences as applicable to diverse areas such as food, agriculture, medical, industrial, environment, genetics, and others.
		PSO2	Demonstrate key practical skills/competencies in working with plants for study and use in the laboratory as well as outside, including the use of good agricultural practices.
		PSO3	Competent enough to use knowledge and skills of plant science to analyze problems involving plant- microbe interactions, food and agriculture, drug research, etc. and articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc
		PSO4	Developed a broader perspective of the discipline of Botany to enable him to identify challenging societal problems and plan his/her professional career to develop innovative solutions for such problems.
		PSO5	
		PSO6	

Programme Specific Outcomes: PSOs are statements that describe what the graduates of a specific educational Programme should be able to do.

These statements are to be written by individual departments offering optional programmes. In addition Language departments also to write general statements for BA, BSc and Commerce Programs. For the Microbiology optional for MCB/MCZ PSOs have been shown as examples. 4-10 PSOs can be written

- **Guidelines for the PSOs**

- Program Specific outcomes basically describe **knowledge and skills of** students as they progress through the program as well as by the time of graduation.
- POs should not be too broad
- They must be aligned with the **Graduation Attributes**

Part B

B.Sc. CBZ Curriculum (B.Sc. CEB, MCB, CBBt, BZBc)

Courses and course completion requirements	No. of credits
General English	
Second language: Introductory Kannada/Kannada/ Hindi/ Sanskrit/ Tamil/ Additional English/French/German.	
Botany	06
Chemistry	
Zoology	
Microbiology	
Biotechnology	
Biochemistry	
Environmental science	
Open elective courses (non-professional)	03
Foundation courses	
Term paper	
Soft skills (IGNITORS)	
Human resource development (HRD)/Theology	
Outreach activity	
Extra and Co-curricular activities	

SUMMARY OF CREDITS IN BOTANY

DEPARTMENT OF BOTANY (UG)								
<u>(2021 onwards)</u>								
<u>Semester 1</u>	Code Number	Title	No. of Hours of Instructions	Number of Hours of teaching per week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	BO-121	Microbial Diversity and Technology	56	04	04	30	70	100
Practical	BO-1P1	Microbial Diversity and Technology	56	04	02	15	35	50
Theory (OE)	BOOE-1	Gardening and Landscaping Technology	45	03	03			
Theory (OE)	BOOE-2	Mushroom Culture Technology	45	03	03			
Total Number of credits:			09					
<u>Semester 2</u>	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	BO-221	Diversity and Conservation of Non Flowering Plants	56	04	04	30	70	100
Practical	BO-2P1	Diversity and Conservation of Non Flowering Plants	56	03	02	15	35	50
Theory (OE)	BOOE-3	Entrepreneurship in Plant Based Drugs	45	03	03			
Theory (OE)	BOOE-4	Waste Management Technology	45	03	03			
Total Number of credits:			09					

Course Outcomes and Course Content

Semester	I
Paper Code	BO-121
Paper Title	Microbial Diversity and Technology
Number of teaching hours per week	04
Total number of teaching hours of theory per semester	56
Number of theory credits	04
Total number of teaching hours of practicals per semester	56
Number of practicals credits	02

Objective of the Paper:

- To understand basic concepts of Microbiology.
- To know the different characteristics of viruses, viroids, bacteria, fungi and lichens and to appreciate the significance of each of them.
- To gain a basic understanding of techniques of microscopy, microbial culture and preservation and sterilization methods.
- To appreciate the diversity and uses of fungi and to apply learnt concepts in fungi and Plant Pathology for the exploration of useful and harmful Fungi.
- To study diverse plant pathogens, symptoms of plant diseases and their control measure will be applied in Agriculture and Food Security.

<u>Content of Theory Course 1</u>		56 Hrs
Unit I		10
Chapter No. 1	Microbial diversity - Introduction to microbial diversity; Hierarchical organization and positions of microbes in the living world. Whittaker's five-kingdom system. Distribution of microbes in soil, air, food and water.	2
Chapter No. 2	History and developments of microbiology - Microbiologists and their contributions (Leeuwenhoek, Louis Pasteur, Robert Koch, <i>Edward Jenner and Alexander Fleming</i>).	2
Chapter No. 3	Microscopy - Working principle and applications of light and electron microscopes (SEM and TEM). Microbiological staining –principles of staining, types of staining - Simple, Gram's, Acid Fast, Endospore and Capsule staining.	6
Unit II		07
Chapter	Culture media for Microbes - Natural and synthetic media, Routine media -	2

No. 4	basal media, enriched media, selective media, indicator media, transport media, and storage media.	
Chapter No. 5	Sterilization methods - Principle of disinfection, antiseptic, tyndallization and Pasteurization, Sterilization - Sterilization by dry heat (Depyrogenation and Bacterial Endotoxin Test)), moist heat, UV light, ionization radiation, filtration. Chemical methods of sterilization - phenolic compounds, anionic and cationic detergents.	3
Chapter No. 6	Bacterial Growth –Growth curve and measurement. Definition of nutritional types of Microbes - autotrophs and heterotrophs, phototrophs and chemotrophs; lithotrophs and organotrophs.	2
Unit III		18
Chapter No. 7	Microbial cultures and preservation - Pure culture, subculturing, Preservation methods-overlaying cultures with mineral oils, lyophilization. Microbial culture collections and their importance. A brief account on ITCC, MTCC and ATCC.	3
Chapter No. 8	Viruses - General structure and classification of Viruses; ICTV system of classification. Structure and multiplication of TMV, CaMV, and Bacteriophage (T2). Cultivation of viruses. Brief account of Viroids, prions and vaccines.	5
Chapter No. 9	Bacteria - General characteristics and classification. Archaeobacteria and Eubacteria. 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. Study of <i>Rhizobium</i> and its applications. A brief account of Actinomycetes. Mycoplasmas and Phytoplasmas - General characteristics and diseases. Economic importance of Bacteria.	10
Unit IV		21
Chapter No. 10	Fungi - General characteristics and classification (Alexopoulos et al. 1996). Thallus organization and nutrition in fungi. Reproduction in fungi (asexual and sexual). Heterothallism and parasexuality. Type study of <i>Pythium</i> , <i>Rhizopus</i> , <i>Puccinia</i> , <i>Agaricus</i> , <i>Penicillium</i> and <i>Aspergillus</i> . <i>Economic importance of fungi (self-study)</i>	11
Chapter No. 11	Lichens – Structure and reproduction. VAM Fungi and their significance. Plant Diseases - Study of Etiology, disease symptoms, vectors if any, disease cycle and control measures of following diseases: Tomato Leaf Curl, Citrus Canker, Sandal Spike, Club Root of Crucifer, Late Blight of Potato, Smut of Jowar Blast of Rice, Red Rot of Sugarcane	10

Suggested Readings:

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. Freeman and Company. New York.
4. Dubey RC and Maheshwari DK. 2007. A textbook of Microbiology, S. Chand and Company, New Delhi.
5. Dubey RC and Maheshwari DK. 2002. A Text book of Microbiology, S.C. Chand and Company, Ltd. Ramnagar, New Delhi.
6. Sharma R. 2006. Text book of Microbiology. Mittal Publications. New Delhi. 305pp.
7. Sharma PD. 1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
8. Vasanthkumari R. 2007. A textbook of Microbiology, BI Publications Pvt. Ltd., New Delhi.

References:

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

BO 1P1: List of Experiments to be conducted

Practical 1: Safety measures in microbiology laboratory and study of equipment/appliances used for microbiological studies (Microscopes, Hot air oven, Autoclave/Pressure Cooker (Validation using biological indicator), Inoculation needles/loop, Petri plates, Incubator, Laminar flow hood, Colony counter, Haemocytometer, Micrometer etc.).

Practical 2: Enumeration of soil/food /seed microorganisms by serial dilution technique.

Practical 3: Preparation of culture media (NA/PDA) sterilization, inoculation, incubation of *E coli* / *B. subtilis*/ Fungi and study of cultural characteristics.

Practical 4: Determination of cell count by using Haemocytometer and determination of microbial cell dimension by using Micrometer.

Practical 6: Simple staining of bacteria (Crystal violet /Nigrosine blue) / Gram's staining of bacteria. Isolation and study of morphology of *Rhizobium* from root nodules of legumes

Practical 7: Preparation of spawn and cultivation of paddy straw (Oyster) mushroom.

Practical 8: Study of vegetative structures and reproductive structures – *Pythium*, *Rhizopus*, *Puccinia*, *Agaricus*, *Penicillium* and *Aspergillus*. (Depending on local availability)

Practical 9: Preparation of agar slants, inoculation, incubation, pure culturing and preservation of microbes by oil overlaying.

Practical 10: Study of Tomato Leaf Curl, Citrus Canker, Sandal Spike, Club Root of Crucifer, Late Blight of Potato, Smut of Jowar, Blast of Rice, Red Rot of Sugarcane (Depending on availability)

Practical 11: Visit to water purification unit/Composting unit/ microbiology lab/ dairy and farms to understand role of microbes in day-to-day life

Course Outcomes and Course Content

Semester	I
Paper Code	BOOE-1
Paper Title	Gardening and Landscaping Technology
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03

Objective of the Paper:

This course is designed to provide orientation and a practical experience in the world of Gardening and landscape. This course will provide a basic background and recent advances in plant science, gardening, floriculture, nursery and landscape, and houseplants. Part of the course will deal with selection and use of plant materials in landscape, landscape design, principles of landscape, maintaining the landscape, types of lawn grasses, lawn installation and lawn maintenance and bedding plant production. Part of the course work will include insight and student orientation in improving the college/ institution landscape and outdoor classroom. This course is considered as an important skill development programme needed for every student for fulfillment of life and accomplishments.

BOOE-1: Gardening and Landscaping Technology

<u>Content of Theory Course 1</u>		45 Hrs
Unit I		12
Unit I	Introduction to Gardening: History, scope, objectives and opportunities	2 hours
	Garden and its components: Indoor and outdoor gardens; Living and non-living elements; Garden plants; Propagating structure; Growing media and manure; Garden implements and tools	8 hours
	Plant propagation techniques: Natural and artificial propagation techniques	2 hours
Unit II		16
Unit II	Types of gardens: Detailed aspects of shade garden, home gardens, terrace garden, vertical garden, teepee garden, string garden, hanging garden, sensory garden, orchidarium, cactus garden, medicinal garden and butterfly garden,	10 hours
	Principles and techniques of Bonsai, Kokedama and Terrarium	3 hours
	Gardens with reference to Biodiversity conservation; Local, regional and global	3 hours

Unit III		11
Unit III	Introduction to landscaping: History, scope, objectives and opportunities	2 hours
	Components of landscaping: Plant components and non-plant components; Classification and significance of selection of plants based on functional, visual, cultural, temporal and ecologically sustainable	5 hours
	Planting design for environmental improvement: Planting design for slope retention, soil conservation, windbreaks, shelter-belts and live fence. Eco-restoration of disturbed habitats like abandoned quarries and mines	3 hours
	Lawn: Types of grasses, creating and maintenance of lawn	1 hour
Unit IV		06
Unit IV	Field visit: Visit to local gardens with reference to gardening and landscape design, plant types, greenhouses and socio-ecological aspects; Submission of report for assignment assessment.	6 hours

Suggested Readings:

1. Adams, J. (1987). Landscaping with herbs. Timber Press, Inc., Oregon.
2. Better Homes and Gardens. (2007). Step-by-Step Landscaping (2nd Edition).
3. Bose, T. K. and Choudhary. (1991). Tropical Garden Plants in Colour. Horticulture and Allied Publishers.
4. Hackett, B. (1979). Planting Design, McGraw Hill.
5. Dell, O. E. (2009). Sustainable Landscaping for Dummies, Wiley Publishing, USA.
6. Dell, O. E. (2015). How to start a home-based landscaping business. Taylor Trade Publishing.
7. Frowine, S. A. (2007). Gardening basics for dummies. Wiley Publishing, USA.
8. Ingels, J. E. (2009). Landscaping: Principles & Practices, (7th Edition). Delmar, USA.
9. Gopaldaswamiengar (1991). Complete gardening in India. Gopaldaswamy Parthasarathy.
10. Mathews, R. (2012). How to design a small garden: Step-by-step landscaping ideas, pictures and plans for planning the perfect small garden. Successful Design Ltd.
11. McLaughlin, C. (2013). Vertical vegetable gardening. Alpha Books, USA.
12. Robinson, N. (1998). The planting design hand book, Gower Pub.
13. Power, P. (2007). How to start your own gardening business. How to Books, UK.
14. Simonds, J. O. (1961). Landscape Architecture: the shaping of man's natural environment. London: F.W. Dodge Cooperation.
15. Starke, B and Simonds, J. O. (2013) Landscape Architecture: A manual of site planning and design. (5th Edition). McGraw-Hill Professional.
16. Walls, A. J. (2020). Landscaping for Beginners: the ultimate step-by-step guide to planning your amazing outdoor space, design walkways, edges, patios, and turn your garden into a beautiful natural landscape. Kindle edition.

Course Outcomes and Course Content

Semester	I
Paper Code	BOOE- 2
Paper Title	Mushroom Culture Technology
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03

Objective of the Paper:

1. Identify and arrange inputs for mushroom cultivation
2. Undertake good quality mushroom production using suitable techniques
3. Undertake basic entrepreneurial skills for small scale mushroom enterprise
4. Practice health and safety at workplace

BOOE-2: Mushroom Culture Technology

<u>Content of Theory Course 1</u>		45 Hrs
Unit I		06
Unit I	Biology and ecology of mushrooms Introduction and history of mushroom cultivation Scope and importance of mushroom cultivation in India and world Nutritional value: (Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins); Health benefits (or) medicinal value of mushrooms Edible mushrooms, poisonous mushrooms and mushroom poisoning	
Unit II		10
Unit II	Cultivation Technology: Infrastructure, equipment and substrates in mushroom cultivation Requirements for Mushroom cultivation: polythene bags, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture racks, mushroom unit or mushroom house, water sprayer, tray, boilers, driers, pure culture Preparation of spawn: Types of spawn, preparation of spawn as pure culture, media used in raising pure culture, culture maintenance, storage of spawn Preparation of compost and mushroom bed: Materials used for compost preparation, compost technology in mushroom production	
Unit III		10
Unit III	Cultivation of important mushrooms:	

	Steps involved in the cultivation of White button mushroom (<i>Agaricus bisporus</i>), Oyster mushroom (<i>Pleurotus ostreatus</i>) and Paddy straw mushroom (<i>Volvariella volvacea</i>) Casing: Preparation of casing material, raw material used for casing and importance of casing	
Unit IV		10
Unit IV	Harvesting, grading, packaging and logistics of mushrooms. Storage of cultivated mushrooms: long term and short-term storage methods. Pests and Pathogens of mushrooms and their management in mushroom culture technology Processing of edible mushrooms.	
Unit V		05
Unit V	Entrepreneurship, marketing and cost-benefit analysis of mushroom cultivation in India and world Economic empowerment of rural farm women through mushroom production Mushroom research centers/farms: Local, regional and national (<u>Self-study</u>)	
Unit VI		04
Unit VI	<u>Mushroom cultivation related documentaries (Self-study)</u>	

References

1. Bahl, N. (2000). Handbook on Mushrooms. Oxford & IBH Publishing Co. New Delhi, India.
2. Gour, P. Y. (2010). Mushroom Production and Processing Technology, Published by Agrobios, Jodhpur, India.
3. Kannaiyan, S. and Ramasamy, K. (1980). A Hand Book of Edible Mushroom. Today & Tomorrows Printers & Publishers, New Delhi.
4. Kaul, T. N. (1999). Introduction to Mushroom Science, Oxford & IBH Co., Pvt. Ltd. New Delhi, India.
5. Marimuthu, T. 1995. Prospects of oyster mushroom cultivation in Tamil Nadu. Journal of Ecobiology, 7 (1): 27-34.
6. Marimuthu, T. *et al.* (1991). Oyster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
7. Miles, P. G. and Chang, S. (1997). Mushroom Biology, World Scientific, Singapore.
8. Pandey, B. P. (1996). A textbook of Fungi. Chand and Company, New Delhi, India.
9. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Published by Agrobios, Jodhpur, India.
10. Ram, R. C. (2007). Mushroom and their Cultivation Technique, Aavishkar Publishers, Distributors, Jaipur, India.
11. Singh, H. (1991). Mushrooms -The art of cultivation. Sterling Publishers Pvt. Ltd. Uttar Pradesh, India.
12. Tripathi, D. P. (2005). Mushroom Cultivation, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, India.

Course Outcomes and Course Content

Semester	II
Paper Code	BO 221
Paper Title	Diversity of Non-Flowering Plants
Number of teaching hours per week	04
Total number of teaching hours of theory per semester	56
Number of theory credits	04
Total number of teaching hours of practicals per semester	56
Number of practicals credits	02

Objective of the Paper: Plants, to most people, mean a wide range of living organisms from the smallest bacteria to the largest living things - the giant *Sequoia* trees. By this definition plants include: algae, fungi, lichens, mosses, ferns, conifers and flowering plants.

To understand the thallus organization, diversity, identification techniques and classification of Algae, Bryophytes, Pteridophytes, and Gymnosperms. To understand algal cultivation techniques and to appreciate the wide usage of non-flowering plants in human welfare.

To study and understand the morphological, internal structure and the reproductive structures of diverse plant groups for the evolution of structure-functions and their application. To understand the geological time scale and fossil taxa of various classes to appreciate the plants evolution, paleoclimate conditions.

BO 221: Diversity of Non-Flowering Plants

Content of Theory Course 2		56 Hrs
Unit I		16
Chapter No. 1	Algae –General characteristics and classification of algae (Fritsch system, 1945), Diversity- habitat, thallus organization, pigments, reserve food, flagella types, life-cycle and alternation of generation in Algae.	4
Chapter No. 2	Morphology and life-cycles of <i>Anabaena</i> , <i>Oedogonium</i> , <i>Chara</i> , <i>Vaucheria</i> , <i>Sargassum</i> and <i>Batrachospermum</i> . Diatoms and their importance.	7
Chapter No. 3	Algal cultivation - Cultivation of microalgae - <i>Spirulina</i> and <i>Dunaliella</i> ; Algal cultivation methods in India. Algal products - Food and Nutraceuticals, Feed stocks, food colorants;	5

	fertilizers, aquaculture feed; therapeutics and cosmetics; medicines; dietary fibres from algae and uses. Harmful effects of algae: Algal blooms and toxins.	
Unit II		14
Chapter No. 4	Bryophytes – General characteristics and classification of Bryophytes (Proskauer 1957), Salient features of class: Hepaticopsida, Anthocerotopsida, and Bryopsida	3
Chapter No. 5	Morphology, anatomy and reproduction of <i>Marchantia</i> , <i>Anthoceros</i> , <i>Funaria</i> (developmental details not required). Economic importance of Bryophytes. Fossil Bryophytes.	4
Chapter No. 6	Pteridophytes - General characteristics and classification; Distribution, morphology, anatomy, reproduction and life-cycles in <i>Psilotum</i> , <i>Lycopodium</i> , <i>Selaginella</i> , <i>Equisetum</i> , <i>Marsilea</i> .	7
Unit III		14
Chapter No. 7	A brief account of heterospory and seed habit. Stelar evolution in Pteridophytes. Affinities and evolutionary significance of Pteridophytes. Ecological and economic importance.	4
Chapter No. 8	Gymnosperms - General characteristics. Distribution and classification (Christenhusz et al., 2011) of Gymnosperms. Study of the habitat, distribution, habit, anatomy, reproduction and life-cycles in <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i> .	8
Chapter No. 9	Affinities and evolutionary significance of Gymnosperms. Economic importance of Gymnosperms - food, timber, industrial uses and medicines.	2
Unit IV		12
Chapter No. 10	Origin and evolution of Plants: Origin and evolution of plants through Geological Time scale.	2
Chapter No. 11	Paleobotany - Paleobotanical records, plant fossils, Preservation of plant fossils - impressions, compressions, petrifications, nodules, moulds and casts. Radio-dating. Exploration of fossil fuels. Contributions of Birbal Sahni.	5
Chapter No. 12	Fossil taxa - <i>Rhynia</i> , <i>Lepidodendron</i> , <i>Calamites</i> , <i>Glossopteris</i> and <i>Pentoxylon</i> .	5

Suggested Readings:

1. Chopra, G.L. A text book of Algae. Rastogi & Co., Meerut, Co., New Delhi, Depot. Allahabad.
2. Johri, Lata and Tyagi, 2012, A Text Book of, Vedame Books, New Delhi.
3. Sharma, O.P. 1990. Text Book of Pteridophyta. McMillan India Ltd. New Delhi.
4. Sharma, O.P. 1992. Text Book of Thallophytes. McGraw Hill Publishing Co. New Delhi.
5. Sharma, O.P., 2017, Algae Singh-Pande-Jain 2004-05. A Text Book of Botany. Rastogi Publication, Meerut.

References:

1. Sambamurty, A.V.S.S.. A Text Book of Algae. I.K. International Private Ltd., New Delhi.

2. Agashe, S.N. 1995. Paleobotany. Plants of the past, their evolution, paleoenvironment and Allied plants. Hutchinson & Co., Ltd., London.
3. Anderson R.A. 2005, Algal cultural Techniques, Elsevier, London.
4. Publication, Application in exploration of fossil fuels. Oxford & IBH., New Delhi.
5. Eams, A.J., (1974) Morphology of vascular plants - Lower groups. Tata McGraw-Hill Publishing Co. New Delhi, Freeman & Co., New York.
6. Fritze, R.E. 1977. Structure and reproduction of Algae. Cambridge University Press.
7. Goffinet B and Shaw A.J. 2009, Bryophyte Biology, 2nd ed. Cambridge University Press, Cambridge.
8. Srivastava, H N, 2003. Algae. Pradeep Publication, Jalandhar, India.
9. Kakkar, R.K. and B.R.Kakkar (1995) The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad.
10. Kumar H. D., 1999, Introductory Phycology, Affiliated East-West Press, Delhi.
11. Lee, R.E., 2008, Phycology, Cambridge University Press, Cambridge. 4th edition. McGraw Hill Publishing Co., New Delhi.
12. Parihar, N.S. 1970. An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book, Allahabad.
13. Parihar, N.S. (1976) An Introduction to Pteridophytes, Central Book Depot, Allahabad.
14. Parihar, N.S. 1977. The Morphology of Pteridophytes. Central Book Depot, Allahabad Press, Cambridge.
15. Rashid, A. 1998. An Introduction to Pteridophyta. II ed., Vikas Publishing House, New Delhi.
16. Smith, G.M. 1971. Cryptogamic Botany. Vol. II. Bryophytes & Pteridophytes. Tata McGraw Hill Publishing, New Delhi.
17. Smith, G.M. 1971. Cryptogamic Botny. Vol.I Algae & Fungi. Tata McGraw Hill Publishing. New Delhi.
18. Sporne, K.R. 1965. The Morphology of Gymnosperms. Hutchinson & Co., Ltd., London.
19. Stewart, W.M. 1983. Paleobotany and the Evolution of Plants, Cambridge University Cambridge.
20. Sundarajan, S. 1997. College Botany Vol. I. S Chand & Co. Ltd., New Delhi.
21. Vanderpoorten, A. and Goffinet, B. 2009, Introduction to Bryophytes, Cambridge University Press, Cambridge.
22. Vashista, B.R. 1978. Bryophytes. S Chand & Co. Ltd., New Delhi.

BO 2P1: List of Experiments to be conducted

Practical-1: Study of systematic position, morphology and reproductive structures of *Anabaena*, *Scytonema*, *Spirulina*.

Practical-2: Study of systematic position, morphology and reproductive structures of *Oedogonium*, *Chara*, *Vaucheria*, *Sargassum*, *Batrachospermum*.

Practical-3: Study of systematic position, morphology and reproductive structures of *Marchantia* & *Funaria*.

Practical-4: Study of systematic position, morphology and reproductive structures of *Psilotum*, *Lycopodium*, *Selaginella*.

Practical -5: Study of systematic position, morphology and reproductive structures of *Equisetum*, *Marsilea*.

Practical -6: Study of systematic position, morphology and reproductive structures in *Cycas*.

Practical -7: Study of systematic position, morphology and reproductive structures in *Pinus*.

Practical -8: Study of systematic position, morphology and reproductive structures in *Gnetum*.

Practical -9: Study of algal diversity from freshwater bodies.

Practical 10: Study of fossils – *Rhynia*, *Lepidodendron*, *Calamites*, *Glossopteris* and Pentoxylon.

Practical-11: Visit to algal cultivation units/lakes with algal blooms/Fern house/Nurseries/Geology/museum/lab to study plant fossils.

(**Note:** Botanical study tour to a floristic rich area for 1-2 days and submission of study report is compulsory)

Course Outcomes and Course Content

Semester	II
Paper Code	BOOE-3
Paper Title	Entrepreneurship in Plant Based Drugs
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03

Objective of the Paper:

The course will provide basic knowledge as well as recent advances in Entrepreneurship in Plant-based Drugs. The course will train the students launch the Start-ups and commercialization of medicinally important plants. The course will deal with selection and use of medicinal plants and their commercialization. The course is considered as an important skill development programme needed for every student for fulfillment of life and accomplishments.

BOOE-3: Entrepreneurship in Plant Based Drugs

<u>Content of Theory Course 1</u>		45 Hrs
Unit I		13
Unit I	Introduction to Entrepreneurship in Plant-based drugs: Scope, objectives and opportunities.	4 hours
	Historical account of the use of plants in the production of drugs and medicines.	4 hours
	Brief account of global status of traditional medicinal systems.	3 hours
	Significance of AYUSH.	2 hours
	Medicinal Plants – past and present status in India and the world.	
Unit II		11
Unit II	Entrepreneurship: Meaning, Concepts, Functions, Process and importance of Innovations. The Indian Scenario of Entrepreneurship.	5 hours
	Understanding the Market and resource Mobilization.	3 hours
	Feasibility Study, opportunity assessment Execution of Business Plan,	3 hours
Unit III		11
Unit III	Entrepreneurship and commercialization opportunities in Plant sciences.	6 hours
	Formulation, processing, production, certification and marketing of new plant-	

	based products: drugs, essential oils and aromatic products. Strategies to substantially improve existing plant-based drug production. Introduction to medicinal plants: Promotion of medicinal plant sector at national level in India. Demand and supply of medicinal plants. A brief account of Herbal industries.	2 hours
		3 hours
Unit IV		10
Unit IV	Medicinal plants of India: Systematics, geographical distribution, medicinal uses production and commercialization of medicinal plants - <i>Catharanthus roseus</i> , <i>Crocus sativus</i> , <i>Curcuma longa</i> , <i>Saraca asoca</i> , <i>Withania somnifera</i> and <i>Rauvolfia serpentina</i> .	10 hours

Suggested Readings:

1. Connect the Dots Rashmi Bansal, 2010, Bloody Good Book, A division of Bushfire Publishers LLP. ISBN: 9788193182178, 9788193182178.
2. Against All Odds Dhirubhai Ambani, 2008, Publisher: McGraw-Hill Education
3. Innovation, Commercialization, and Start-Ups in Life Sciences, James F. Jordan, 2014, CRC Press,
4. Bioscience entrepreneurship in Asia, 2008, P. S. Teng, World Scientific Publishing Co Pte Ltd.
5. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Craig Shimasaki, 2014, Elsevier.
6. Bio-entrepreneurship and Transferring Technology in to Product Development. Swati Agarwal, Sonu Kumari, Suphiya Khan, 2021, ISBN13: 9781799874119, IGI Global.
7. Indian Medicinal Plants: A Compendium of 500 Species, P. K. Warrier, 2007, Orient Blackswan Private Limited - New Delhi.
8. Glossary of Indian Medicinal Plants, Ram Nath Chopra, 1996, Publications & Information Directorate
9. Encyclopedia of Indian Medicinal Plants: Rational Western Therapy, Ayurvedic and Other Traditional Usage, Botany HRD Edition C. P. Khare, 2009, Springer Verlag
10. The Treatise on Indian Medicinal Plants, Asima Chatterjee, Satyesh Chandra Pakrashi, 1991, Publications & Information Directorate
11. Benefits of Plant Based Medicine: A Patient's Guide to Plant-Based Medicine, Essential Oils and Natural Remedies that can Treat, Heal and Prevent Disease, Howard Mason, Independently Published (8 January 2020), ISBN-10: 1657732401
12. Plants of Commercial Values, Bikarma Singh, 2019, CRC Press. ISBN 9780367819361

Course Outcomes and Course Content

Semester	II
Paper Code	BOOE-4
Paper Title	Waste Management Technology
Number of teaching hours per week	03
Total number of teaching hours of theory per semester	45
Number of theory credits	03

Objective of the Paper:

The course will provide basic knowledge as well as recent advances in waste management. The course will train the students to launch the Start-ups and commercialization waste management. Part of the course will be dealing with waste management and understanding various types of waste and their impact on the human health and environment. This course is considered as an important skill development programme needed for every student for fulfillment of life and accomplishments.

BOOE-4: Waste Management Technology

<u>Content of Theory Course 1</u>		45 Hrs
Unit I		06
Unit I	<p>Introduction to Waste management: Brief history, problems, need, types and issues of waste management.</p> <p>Functional elements: waste generation, storage, collection, transfer, transport, processing, recovery and disposal and management of urban waste.</p> <p>Generation and characteristics of waste: Sources, Types, composition, quantity, sampling and characteristics of waste, factors responsible for the generation of solid waste.</p>	6 hours
Unit II		15
Unit II	<p>Types of Solid Waste –</p> <p>Municipal solid waste: Definition, sources, management, treatment and disposal. 3 hours</p> <p>Industrial Waste: Generation of waste during manufacturing and packing, , minimization at source and disposal. 3 hours</p> <p>Hazardous waste: Definition, sources, hazardous characteristics, management, treatment and disposal. 2 hours</p> <p>Electronic waste: Waste characteristics, generation, collection, transport and</p>	

	disposal Biomedical waste: Definition, sources, classification, collection, segregation, Color-coding, treatment and disposal. Waste collection, storage and transport - Collection and storage of solid waste; Methods of collection, on site storage, transfer station, transportation, storage containers and collection crew.	2 hours 2 hours 3 hours
	Unit III	08
Unit III	Recycling of waste: 5 R's: Refuse, Reduce, Reuse, Repurpose, Recycle Wealth from waste: Production of useful products from waste; Vermi-composting, Biogas production and Sewage Treatment Plant. Recycling of plastic, paper and e-waste.	8 hours
	Unit IV	16
Unit IV	Disposal of Solid Waste: Segregation, volume reduction at source, recovery and management of residual waste. Sanitary landfills: Site selection, design and operation of sanitary landfill, leachate and gas management, landfill closure and environmental monitoring, landfill remediation. Case study of Municipal solid waste management in India – Indore Model. Rules and regulations (legal aspects) governing disposal and management of solid waste. Role of agencies for disposal and management of solid waste. Field visit and report submission: Visit to solid waste management facilities	11 hours 5 hours

Suggested Readings:

1. Integrated management of municipal solid waste. Environmental Security: Human and Animal Health by Ramachandra, T. V., IBDC Publishers, India (2011)
2. Handbook of Solid Waste Management by Frank Kreith and George Tchobanoglous. McGraw-Hill Handbooks (2002)
3. Hazardous waste Management by Charles A. Wentz. McGraw –Hill International Edition (1996)
4. Municipal Solid Waste Management in Developing Countries by Kumar S, 1st Edition, (2016)
5. Organic Waste Recycling: Technology, Management and Sustainability by Chongrak Polprasert and Thammarat Koottatep. IWA Publishing (2017)
6. Solid Waste Recycling and Processing: Planning of Solid Waste Recycling Facilities and Programs by Marc J. Rogoff. William Andrew Publishers (2013)
7. Waste Management Practices: Municipal, Hazardous, and Industrial by Pitchel, 1st Edition. CRC Press (2005)
8. Waste: A Handbook for Management by Letcher, Trevor M., Vallero, Daniel A. Academic Press (2011)
9. Solid Waste Recycling and Processing: Planning of Solid Waste Recycling Facilities and Programs by Marc J. Rogoff. William Andrew Publishers (2013)
10. Organic Waste Recycling: Technology, Management and Sustainability by Chongrak Polprasert and Thammarat Koottatep. IWA Publishing (2017)

