

John Wilson Education Society's

Wilson College (Autonomous) Chowpatty, Mumbai - 400007

RE-ACCREDITED 'A' Grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Syllabus for S.Y. Program: B. Sc - BOTANY

Program Code: WSBOT

Choice Based Credit System (CBCS)

w.e.f.

Academic year: 2024-25

(Under NEP)

Wilson College (Autonomous)
Department of Botany Proposed S. Y. B. Sc. (Revised) Syllabus under NEP 2020
(To be implemented from the Academic year 2024-25)

Program: B.Sc.

Program Objectives (POs)

- PO1. To consolidate the disciplinary knowledge through classroom and field studies.
- PO2. To enhance critical thinking skills via written assignments, essay and review writing.
- PO3. To upgrade communication skills and self-directed learning via curricular, co-curricular and extra-curricular activities.
- PO4. To promote employability and entrepreneurship skills by providing hands-on training.
- PO5. To endeavor towards holistic development of the learners.

Program Specific Outcomes (PSOs)

The Learners (Graduates) will be able to -

- PSO1. Apply the knowledge acquired for exploring different facets of plant sciences.
- PSO2. Address environment related issues/concerns.
- PSO3. Apply the principles and practice the techniques learnt in routine and professional life.
- PSO4. Analyze information/data and use statistical tools to arrive at a judicious conclusion.
- PSO5. Use knowledge of plant sciences for personal, professional, environmental and societal benefits.
- PSO6. Develop an aptitude towards research in plant sciences and allied fields.

PROGRAM OUTLINE**2024-2025**

SEM	COURSE CODE	COURSE TITLE	Credits
III	WSBOTMJ231	Plant Diversity II	2
	WSBOTMJ232	Form & Function – II	2
	WSBOTMJ233	Botany Practical-3	2
	WSBOTMN231	Plant Forms	2
	WSBOTMN232	Botany Minor Practical- 3	2
	WABOTOE231	Aromatic Plants: Herbs and Nerves	2
	WSBOTSE231	Essential skills for Botanists	2
	WSBOTVE231	Agrodiversity and Food Diversity of India	2
IV	WSBOTMJ241	Form & Function – II	2
	WSBOTMJ242	Current Trends in Plant Science I	2
	WSBOTMJ243	Botany Practical- 4	2
	WSBOTMN241	Plant Functions and Applications	2
	WSBOTMN242	Botany Minor Practical- 4	2
	WABOTOE241	Ethnobotany	2
	WSBOTOE242	Medicinal Botany	2
	WSBOTVS 241	Food Processing and Preservation	2

SEMESTER III
MAJOR THEORY COURSE- I

PROGRAM: S. Y. BSc.		SEMESTER: III	
Course: Plant Diversity II		Course Code: WSBOTMJ231	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
2	2	40	60
Learning Objectives			
<p>The specific objectives of this course are:</p> <ol style="list-style-type: none"> 1. To study the systematic position and general characteristics of representative genera/ Families of Fungi, Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. 2. To explain different stages in the life cycle of the representative members of different plant groups. 3. To study the different aspects of the plants and their application. 			
Course outcomes			
<p>The learners will be able to:</p> <p>CO1- Identify Fungi, Algae, Bryophytes, Pteridophytes and Gymnosperms based on their characters.</p> <p>CO2- Examine various stages in the life cycle of the selected genera studied from Fungi, Algae, Bryophytes, Pteridophytes and Gymnosperms.</p> <p>CO3- Describe and compare types of Inflorescence based on morphological features.</p> <p>CO4- Establish the premise of Angiospermic studies via morphology and principles of Plant Systematics.</p> <p>CO5- Compare various systems of Classification of Angiosperms.</p>			

Course Title	PLANT DIVERSITY		2 Credits
Course Code	WSBOTMJ231		
Unit I	Thallophyta and Cryptogams		15 Lectures
	Fungi		
	1.1	General characters of Ascomycetae.	
	1.2	Structure, life cycle and systematic position of <i>Aspergillus</i> .	
	Algae		
	1.3	General Characters of Division Phaeophyta	
	1.4	Structure, life cycle and systematic position of <i>Sargassum</i> .	
	Bryophytes		
	1.5	General Account of Class: Musci	
	1.6	Structure, life cycle and systematic position of <i>Funaria</i>	
	Pteridophytes		
	1.7	General Characters of Lepidophyta	
1.8	Structure, life cycle and systematic position of <i>Selaginella</i> .		
Unit II	Phanerogams		15 Lectures
	Gymnosperms		
	2.1	Salient features of Coniferophyta	
	2.2	Structure, life cycle and systematic position of <i>Pinus</i> .	
	Angiosperms		
	2.3	Types of Inflorescence	
	2.4	Systematics: Objectives and Goals of Plant Systematics.	
	2.5	Introduction to Classification systems of Angiosperms	

	2.6	Study the vegetative, floral characters, economic importance and present status as per Bentham and Hooker's classification of the following families: <ul style="list-style-type: none"> ○ Fabaceae ○ Areaceae 	
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SEMESTER III
MAJOR THEORY COURSE- II

PROGRAM: S. Y. B. Sc		SEMESTER: III	
Course: Form & Function –II		Course Code: WSBOTMJ232	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
2	2	40	60
Learning Objectives			
The specific objectives of this course are: <ol style="list-style-type: none"> 1. 1.To study the role of cell cycle in cell division. 2. To learn the structure and functions of DNA and RNA 3. To learn the process of transcription during protein synthesis 4. To study secondary growth and types of mechanical tissue. 5. To study the anatomical adaptations in response to habitats. 			
Course Outcomes			
The learners will be able to: <ul style="list-style-type: none"> CO1- Discuss the cell cycle and its importance in plant growth and the development. CO2- Compare different forms of nucleic acids. CO3- Explain the process of DNA Replication and Transcription. CO4- Differentiate between secondary growth in dicot stem and root. CO5- Distinguish the distribution pattern of mechanical tissues. CO6- Compare adaptive features of hydrophytes and xerophytes 			

Course Title	Form and Function II		2 Credits
Course Code	WSBOTMJ232		
Unit I	Cell and Molecular Biology		15 Lectures
	1.1	Cell Division and its significance: Cell Cycle, structure of Interphase Nucleus (nuclear envelope, chromatin network, nucleolus and nucleoplasm)	
	1.2	Biomolecules: Types, structures and functions of DNA and RNA.	
	1.3	DNA replication: <ul style="list-style-type: none"> ● Messelson and Stahl Experiment. ● DNA replication in prokaryotes and eukaryotes. ● Enzymes involved and molecular mechanism of replication. 	
	1.4	Protein Synthesis: <ul style="list-style-type: none"> ● Central dogma of Protein synthesis. ● Transcription in prokaryotes and eukaryotes- promoter sites, initiation, elongation and termination. ● RNA processing- Adenylation, Capping and RNA splicing. 	
Unit II	Plant anatomy		15 Lectures
	1.1	Normal Secondary Growth in Dicotyledonous stem and root.	
	1.2	Growth rings, Periderm, Lenticels, Tyloses, Heart wood and Sap wood.	
	1.3	Mechanical Tissue system <ul style="list-style-type: none"> ● Tissues providing mechanical strength and support and their disposition. ● I-girders in aerial and underground organs. 	
	1.4	Types of Vascular Bundles	
	1.5	Anatomical adaptations in Hydrophytes and Xerophytes	

BOTANY PRACTICAL - 3

PROGRAM: S. Y. BSc.		SEMESTER: III	
Course: BOTANY PRACTICAL- 3		Course Code: WSBOTMJ233	
Credit Scheme		Evaluation Scheme	
Practical (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
4	2	40	60

Course Code	Course Title	Credit
WSBOTMJ233	BOTANY PRACTICAL- 3 (Part A)	2
Thallophyta and Cryptogams		
1	Study of stages in the life cycle of <i>Aspergillus</i> from fresh/ preserved material and permanent slides.	
2	Study of stages in the life cycle of <i>Sargassum</i> from fresh/ preserved material and permanent slides.	
3	Study of stages in the life cycle of <i>Funaria</i> from fresh/ preserved material and permanent slides.	
4	Study of stages in the life cycle of <i>Selaginella</i> from fresh/ preserved material and permanent slides.	
Phanerogams		
5	Study of stages in the life cycle of <i>Pinus</i> from fresh/ preserved material and permanent slides.	
6	Study of types of inflorescence	
7	Study of the morphological peculiarities and economic importance of the member of Fabaceae	
8	Study of the morphological peculiarities and economic importance of the member of Arecaceae	
Local Field Visits- Two Visits (Reports of field visits will be evaluated in either internal or external examination)		
BOTANY PRACTICAL-3 (Part B)		
Cell and Molecular Biology		
1	Study of meiosis from suitable plant material.	
2	Study of types of DNA and RNA with the help of illustrations/Models	
3	Estimation of proteins by Lowry's method	

4	Predicting the sequence of amino acids in the polypeptide chain that will be formed following translation (Prokaryotes and Eukaryotes)
Plant Anatomy	
5	Study of normal secondary growth in the stem and root of a Dicot plant
6	Study of anatomy of Xerophytes
7	Study of anatomy of Hydrophytes
8	Study of mechanical tissue systems in aerial, underground organs.
9	Study of different types of vascular bundles, Growth rings, periderm, lenticels, tyloses, heart wood and sap wood

**SEMESTER III
MINOR THEORY**

PROGRAM(s): S. Y. BSc.		SEMESTER: III	
Course: Plant Forms		Course Code: WSBOTMN231	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
2	2	40	60
<p>Learning Objectives The specific objectives of this course are:</p> <ol style="list-style-type: none"> 1. To study the general characteristics of Algae and Bryophytes and their economic and ecological values. 2. To study the different aspects of the plants and their application with respect to taxonomy 3. To study the systematic position of selected plants from different plant groups. 4. To explain different stages in the life cycle of the representative members of different plant groups. 5. To expose students to the ecological and economic significance of lower and higher forms of plants. 			

Course outcomes

The learners will be able to:

CO1- Examine various stages in the life cycle of the Algae, Bryophytes and Pteridophytes studied.

CO2- Describe the significance of mycorrhiza. .

CO3 - Examine / compare sporophytes of Bryophytes.

CO4 - Establish the premise of Angiospermic studies via morphology and taxonomic tools.

CO5 - Apply the knowledge of angiosperms in identification, nomenclature and classification.

CO6 - Appreciate floristic diversity during field studies.

Course Title		PLANT FORMS	2 Credits
Course Code		WSBOTMN231	
Unit I	Thallophyta and Cryptogams		15 Lectures
	1.1	Phaeophyta- Salient features, Diversity of thallus Structure, life cycle and systematic position of <i>Fucus</i>	
	1.2	Mycorrhiza: Ectomycorrhiza and Endomycorrhiza and their Significance	
	1.3	Basidiomycetes: Salient Features Spore dispersal mechanism in basidiomycetes, Bioluminescence	
	1.4	Sporophytes of Bryophytes Structure, life cycle and systematic position of <i>Funaria</i>	
	1.5	Pteridophytes of India: Diversity, distribution Structure, life cycle and systematic position of <i>Selaginella</i>	
	1.6	Paleobotany- The geological time scale; Formation and types of fossils; Structure and systematic position of form genus <i>Rhynia</i> .	
Unit II	Phanerogams		15 Lectures
	2.1	Salient features of Coniferophyta Structure, life cycle and systematic position of <i>Ginkgo biloba</i>	
	2.2	Ecological and Economical importance of Coniferophyta	
	2.3	Introduction to Plant Systematics.	
	2.4	Importance of Binomial Nomenclature	
	2.5	Branches of Taxonomy	

	2.6	Study the vegetative, floral characters, economic importance and present status as per Bentham and Hooker classification of the following families: <ul style="list-style-type: none"> ● Malvaceae ● Solanaceae ● Arecaceae 	
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**SEMESTER III
BOTANY MINOR PRACTICAL-3**

PROGRAM: S. Y. BSc.		SEMESTER: III	
Course: BOTANY MINOR PRACTICAL- 3		Course Code: WSBOTMN232	
Credit Scheme		Evaluation Scheme	
Practical (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
4	2	40	60

Course Code	Plant Forms	Credits 2
WSBOTMN232	BOTANY MINOR PRACTICAL-3	
Thallophyta and Cryptogams		
1	Study of stages in the life cycle of <i>Fucus</i> from fresh/ preserved material and permanent slides.	
2	Study of the Ectomycorrhiza and Endomycorrhiza with the help of Permanent slide	
3	Understanding Sporocarp and its diversity in Basidiomycetes on field (A dedicated Field visit will be organized on Malabar Hill/SGNP to observe Basiodiomycetes)	
4	Study of stages in the life cycle of <i>Funaria</i> from fresh/ preserved material	

	and permanent slides.	
5	Study of stages in the life cycle of <i>Selaginella</i> from fresh/ preserved material and permanent slides.	
6	Study of stages in life cycle of <i>Rhynia</i> using photomicrograph	
7	Local Field visit- 1	
Phanerogams		
8	Study of stages in the life cycle of <i>Ginkgo biloba</i> from fresh/ preserved material and permanent slides.	
9	Identification of Ornamental conifers with special features	
10	Study of Palyno Taxonomy with the help of Pollen observations	
11	Study of the morphological peculiarities and economic importance of the member of Malvaceae	
12	Study of the morphological peculiarities and economic importance of the member of Solanaceae	
13	Study of the morphological peculiarities and economic importance of the member of Arecaceae	
14	Local Field Visit-1	

References for Semester III

1. Textbook of Algae by Sharma O.P. (Tata McGraw-Hill Co, New Delhi).
2. Algae by Vashishtha. (S. Chand Publishers- New Delhi).
3. A Textbook of Algae by Sambamurty A.V.S.S. (I.K.International Ltd New Delhi).
4. A Textbook of Botany by A.K. Thakur, S.K. Bassi. (S. Chand Publishers-New Delhi).
5. Botany for degree students-Fungi- Vashishtha, B.R. and Sinha, A.K. (S. Chand Publishers- New Delhi).
6. Cryptogamic Botany Volume I, G. M. Smith
7. Botany for degree students- Gymnosperms- Vashishtha, B.R., inha, A.K and A. Kumar (S. Chand Publishers- New Delhi)
8. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agarwal, S. Chand & Company Ltd.
9. Cell Biology by Bruce Albert, W.W. Norton & Co publication.

10. Principles of Biochemistry by A.L. Lehninger, D. L. Nelson and M. M. Cox
11. Fundamentals of Biochemistry, J L Jain, Nitin Jain & Sunjay Jain, S. Chand publication.
12. Genetics by Peter J. Russell, Benjamin-Cummings Publishing.
13. Principles of Genetics, by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad, Wiley publications.
14. Khandelwal, K. (2008). Practical pharmacognosy. Pragati Books Pvt. Ltd.
15. Satyanarayana, U. (2013). Biochemistry. Elsevier Health Sciences.

SEMESTER III

Modality of Assessment

(For Botany Major and Minor Courses)

Theory Examination Pattern:

A. Internal Assessment- (40%)- 40 Marks per course

Sr. No.	Evaluation Type	Marks
1.	Written Objective Examination	20
2.	Assignment/ Case study/ Field visit report/ Presentation/ Project/ Theme based photography/Open Book Test	20
	Total	40

B. External Examination- (60%) - 60 Marks per course

Semester End Theory Examination:

1. Duration - This examination shall be of **two hours** duration.
2. Theory question paper pattern: All questions shall be compulsory with internal choice within the questions given as below.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q 1.1 Descriptive	100%	10+10	Unit I
Q1.2 Short Notes	100%	5+5	

Q 1.1 Descriptive	100%	10+10	Unit II
Q1. 2 Short Notes	100%	5 + 5	
	TOTAL	60	

Examination Pattern for Major and Minor Practicals:

A. Internal Examination: (40%)- 20 Marks

Particulars	Practical Course: Major/Minor
Journal	5
Experimental tasks	10
Participation	5
Total	20

B. External Examination: (60%)- 30 Marks

Semester End Practical Examination:

Particulars	Practical Course: Major/Minor
Laboratory work	24
Spots/Viva	6
Total	30

PRACTICAL BOOK/JOURNAL- CERTIFICATION RULES

- The students are required to perform 75% of the Practical for the journal to be duly certified.
- The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

SEMESTER III
OE- Aromatic Plants: Herbs and Nerves

PROGRAM: S. Y. B. Sc		SEMESTER: III		
Course: Aromatic Plants: Herbs and Nerves			Course Code: WABOTOE231	
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Assessment 60 Marks
2	NA	NA	2	2 Assignments (30+30 Marks)
Learning Objectives				
The specific objectives of this course are:				
<ol style="list-style-type: none"> 1. To learn the history of aromatherapy. 2. To learn the importance of essential oils in different therapeutic treatments. 3. To learn the necessity of ethical values while giving and taking treatment. 				
Course Outcomes				
The learners will be able to -				
CO1- Describe the principles of aromatherapy.				
CO2- Analyze the effects of essential oils as per their properties.				
CO3- Apply the knowledge of aromatherapy for the wellbeing of humans.				
CO4- Evaluate the safety concerns related to aromatherapy.				
CO5- Apply the fundamental principles of medical and moral ethics.				

Course Title		Aromatic Plants: Herbs and Nerves	2 Credits
Course Code		WABOTOE231	
Unit I	1.1	Introduction to the aromatic plants of India	15 Lectures
	1.2	The history of aromatherapy	
	1.3	Properties, extraction and preservation of Essential oils	
	1.4	Concept of Base and Carrier Oils.	
	1.5	Benefits of Aromatherapy <ul style="list-style-type: none"> ● Psychological and physiological effects of essential oils 	
Unit II	2.1	List of prescribed essential oils	15 Lectures
	2.2	Aromatherapy for Women	
	2.3	Aromatherapy for Men	
	2.4	Aromatherapy for Children	
	2.5	The hazards associated with essential oils/absolutes - toxicity, irritation, sensitisation, carcinogenesis, phytoestrogens	
	2.6	Legislation and Code of Ethics <ul style="list-style-type: none"> ● Confidentiality ● Data protection ● Medical ethics ● Rights of patient and rights of therapist to refuse the treatment ● Moral and ethical conduct 	

References for Aromatic Plants: Herbs and Nerves

1. Battaglia, S. (2003). The complete guide to Aromatherapy, Second edition, The perfect potion paperback 202 pages ISBN: 0646428969
2. Clarke, S. (2002). Essential chemistry for safe Aromatherapy. Churchill Livingstone Paperback 256 pages, ISBN: 0443064857
3. Gascoigne, S. (1992). Prescribed drugs and the Alternative Practitioner: The Essential Guide. Energy Medicine Press, ISBN:1-85398-022-6

4. Price, S. (1999). Aromatherapy for health care professionals. Churchill Livingstone. Paperback 394 pages
ISBN: 04430621

SEMESTER III
SEC - Essential Skills for Botanist

PROGRAM: S. Y. BSc.				SEMESTER: III	
Course: Essential Skills for Botanist				Course Code: WSBOTSE231	
Teaching Scheme				Evaluation Scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Practical Examination (Marks- 60)
-	4	NA	2	NA	60
Learning Objectives					
<p>The specific objectives of this course are:</p> <ol style="list-style-type: none"> 1. To train students to use microscopy and staining techniques for micromorphological and anatomical observations. 2. To acquire drawing skills which will be helpful in sketching diagrams/illustrations 3. To develop observational skills for comparative study of life forms 4. To develop appreciation and evaluative skills related to biodiversity and ecosystems 5. To develop problem solving, instrumental and analytical skills in the students 6. To develop communication skills among the students 					
Course outcomes					
<p>The learners will be able to</p> <p>CO1- Apply the observational skills for comparative study of plants.</p> <p>CO2- Produce scientific diagrams/illustrations in a better manner.</p> <p>CO3- Appreciate and evaluate the biodiversity and ecosystems.</p> <p>CO4- Develop the communication skills required to prepare the reports, popular articles, educational charts etc.</p> <p>CO5- Apply knowledge of microscopy and staining techniques for comparative study of plants.</p> <p>CO6- Extract, isolate and estimate the plant biomolecules/ingredients of interest.</p> <p>CO7- Analyze and interpret the data related to the study of plants.</p> <p>CO8- Acquire communication skills required in scientific writing.</p>					



Course Title		Essential Skills of Botanist (Practical Based Course)	Credits 2
Course Code		WSBOTSE231	
Part I	1	Study microscopy with the help of appropriate plant materials using Dissecting, and Binocular microscopes	
	2	Study of the microscopy with the help of appropriate plant materials using Binocular microscopes	
	3	To acquire basic skills of diagrams/illustrations related to plants (habit, leaves, flower, inflorescence, tissues, micromorphology etc.)	
	4	Comparative study of plants with the help of morphological characters - leaves, inflorescence, bark etc. (this will be a foundation for identification of plants with the help of flora)	
	5	To appreciate plant diversity/biodiversity of an area w.r.t. its status, composition, level and overall importance (a local visit to an area rich in BD is recommended)	
	6	To examine/evaluate ecosystem w.r.t. its status, importance, ecosystem services, threats etc. (Visit to any ecosystem-mangrove, coastal ecosystem, forest, grassland etc. recommended)	
	7	To solve problems based on quantitative characteristics of plant communities (frequency, density, biodiversity index, plant cover etc)	
	8	To study techniques of plant collection and preservation (dry/herbariums/wet preservation)	
	9	To develop writing and communication skills (through field reports, popular articles, charts, educational contents etc.)	
Part II	1	To study microscopy (compound microscope), section skills and staining techniques with the appropriate plant materials. Sections - T.S., V.S., L.S., TLS, RLS	
	2	Stains -methylene/cotton blue, safranin, light/fast green, acetocarmine, etc.)	
	3	To learn extraction techniques of various biomolecules - pigments/ proteins.	
	4	To study quantitative estimation of DNA	
	5	To learn electrophoresis techniques - casting of gel, loading and running of samples of proteins/DNA	
	6	To study various programs/ software required in bio-statistical operations- t-test	
	7	To learn basic bioinformatic tools -BLAST	
	8	To learn problem solving skills - problems based on quantitative estimation and biostatistics	
	9	To acquire scientific communication skills via attempts of writing- review paper, research paper, scientific articles and posters.	

Reference: The manual will be prepared compiling relevant contents from varied references.

SEMESTER III
VEC - Agrodiversity and Food Diversity of India

PROGRAM: S. Y. B.Sc.				SEMESTER: III	
Course: Agrodiversity & Food Diversity of India				Course Code: WSBOTVE231	
Teaching Scheme				Evaluation Scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	TWO assignments of 30 marks each (Total Marks- 60)
2	NA	NA	2	NA	60

Learning Objectives

The specific objectives of this course are:

1. To expose students to the concept, importance and status of agrodiversity of india
2. To make students aware with the relationship of geography, seasons, climate and agriculture
3. To know and evaluate the position of India as a crop center and threats to agrodiversity
4. To understand the relation between animal husbandry and agriculture.
5. To make students familiar with the threats/challenges and measures of conservation of agriculture and discuss about future of Indian agriculture
6. To expose students to the Indian food diversity, its history and important highlights of Indian Food
7. To study food diversity of India w.r.t. regions, cultures, seasons, festivals, etc
8. To understand and analyze the Indian food diversity w.r.t. tourism, journalism and literature

Course outcomes

The learners will be able to

CO1- Explain the concept of agrodiversity and its status.

CO2- Summarise the role and importance of agrodiversity.

CO3 -Analyze the values/importance of agrodiversity and the relations between agriculture, geography, seasons and climate.

CO4 -Evaluate the position of India as a crop center and the link between animal husbandry and agriculture

CO5- Criticize the threats, challenges, socio-political concerns and conservation efforts w.r.t. Indian agriculture.

CO5 -Judge the future of Indian agriculture

CO6 - Explore the Indian food diversity, its history and important highlights of Indian Food

CO7 - Compare the food diversity of India under the contexts of regions, religions, cultures, seasons etc.

CO8 - Evaluate the popular food styles of India in the lights of globalization.

CO9 - Discover the links between diverse food cultures and tourism, literature and journalism.

Course Title	Agrodiversity and Food Diversity of India		2 Credits
Course Code	WSBOTVE231		
Unit I	Agrodiversity of India		15 Lectures
	1.1	What is agrodiversity?	
	1.2	Status of agrodiversity or crop diversity in India	
	1.3	Importance of agrodiversity	
	1.4	Geography, climate, seasons and agriculture	
	1.5	India as a center of origin of crops	
	1.6	Animal husbandry as an allied branch of agriculture	
	1.7	Threats or challenges to agrodiversity	
	1.8	Socio-political concerns and agriculture	
	1.9	Conservation of agrodiversity	
	1.10	Future of indian agriculture	
Unit II	Food Diversity of India		15 Lectures
	2.1	Indian food - introduction, history and highlights of Indian food	
	2.2	Indian regions and food diversity	
	2.3	Indian cultures and food diversity	
	2.4	Seasons and food	
	2.5	Religions, rituals and food	
	2.6	Food as an identity marker	
	2.7	Concept of <i>Chauras Ahaar</i> - Square Diet	
	2.8	Indian food: therapy/health approach	
	2.9	Popular food styles of India and globalization of Indian food	

	2.10	Food diversity of India w,r,t, tourism, journalism and literature	
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References for Biodiversity and Food Diversity of India

1. Biodiversity, Agroecology, Regenerative Organic Agriculture by Vanda
2. Agriculture and Food in India, A Half Century Review, Bruno Dorin and Frederic Landy
3. Advanced Textbook on Food and Nutrition, Vol-I by Dr. M. Swaminathan, the Bangalore Press
4. Indian Food - A Historical Companion by K. T. Achaya, Oxford University Press New Delhi
5. THE Lost Foods of India... Food and Spirituality by Dr. Abhijit Dam, Notion Press

**SEMESTER IV
MAJOR THEORY COURSE-I**

PROGRAM: S.Y. B. Sc		SEMESTER: IV	
Course: Form and Function II		Course Code: WSBOTMJ241	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
2	2	40	60
<p>Learning Objectives: The specific objectives of this course are:</p> <ol style="list-style-type: none"> 1. To understand the types of chromosomal aberrations. 2. To introduce students to extranuclear genetics and basic principles of plant breeding 3. To learn the process of photosynthesis and special adaptive features of the plants w. r. t. various photosynthetic pathways. 4. To understand the role of edaphic factors w. r. t. plant growth 5. To study the characteristics of plant communities plant succession. 6. To study phytogeographical regions of India. 7. To make students aware with the social models of applied forestry 			

Course outcome

The learners will be able to

- CO1- Characterise the structural chromosomal aberrations.
- CO2- Differentiate between the types of extranuclear genetics characteristics.
- CO3- Describe the basic principles of plant breeding.
- CO4- Explain the role of polyploidy in plant breeding.
- CO5- Describe various pathways involved in photosynthesis.
- CO6- Correlate the edaphic/soil factors with plant growth and development.
- CO7- Identify, characterize and compare the forest types on the basis of ecological factors.
- CO8- Analyze the successive developments of plant communities during ecological succession

SEMESTER IV MAJOR THEORY COURSE-I

Course Title	Form and Function II	2	
Course Code	WSBOTMJ241	Credits	
Unit I	Plant genetics and physiology		
	1.1	Variation in Chromosome structure (Chromosomal Aberrations): Definition, Origin, Cytological and Genetic Effects of the following: Deletions, Duplications, Inversions	15 Lectures
	1.2	Extranuclear Genetics: Organelle heredity- ○ Chloroplast determines heredity – Plastid transmission in plants, Streptomycin resistance in <i>Chlamydomonas</i> . ○ Male sterility in maize.	
	1.3	Introduction to numerical chromosomal aberrations with respect to plant breeding, Polyploidy in Plant breeding	
	1.4	Photosynthesis: Two pigment systems, Light dependent reaction, photophosphorylation, Carbon assimilation pathways: C3 cycle, Photorespiration, C4 cycle and CAM cycle.	
	Plant Ecology		
	2.1	Edaphic factors: Characteristics of soil, Types of Soil, Soil profile, Soil formation, Importance of soil in crop production.	15 Lectures
	2.2	Concept and Characters of Plant Community	

Unit II	2.3	Succession ecology: Concept of Seres- Hydroseres, Xerosere	
	2.4	Phytogeographical regions of India	
	2.5	Major Forest types of India	
	2.6	Applied Forestry: Agro-forestry, Urban forestry.	



**SEMESTER IV
MAJOR THEORY COURSE-II**

PROGRAM: S.Y. B. Sc		SEMESTER: IV	
Course: Current Trends in Plant Sciences I		Course Code: WSBOTMJ242	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
2	2	40	60
<p>Learning Objectives: The specific objectives of this course are:</p> <ol style="list-style-type: none"> 1. To introduce the concept and the significance of nutraceuticals. 2. To make students aware of the industrial applications of enzymes. 3. To expose the student to different plant tissue culture techniques and their applications. 4. To introduce the students to various branches of Horticulture. 5. To familiarize the students with the economically important plants. 			
Course outcome			
<p>The learners will be able to</p> <p>CO1- Explain the use of plants in nutraceuticals. CO2- Describe the industrial applications of enzymes. CO3- Classify and characterize the alcoholic and nonalcoholic beverages. CO4- Explain and differentiate between the plant tissue culture techniques and their applications. CO5- Characterise the branches of Horticulture and their importance. CO6- Analyze the value of economically important plants. CO7- Describe the methods and techniques of cultivation of commercial crops. CO9- Evaluate the significance of greenhouse technology.</p>			

Course Title	CURRENT TRENDS IN PLANT SCIENCES I		2 Credits
Course Code	WSBOTMJ242		
Unit I	Industrial Botany		15 Lectures
	1.1	Nutraceuticals: Introduction and nutraceutical values of <i>Spirulina</i> , <i>Chlorella</i> and <i>Vanilla</i> .	
	1.2	Enzymes industry: Sources and uses of Cellulases, Lipase, Papain.	
	1.3	Beverages: Alcoholic (Beer and Wine) and Non-alcoholic (Tea, Coffee, Neera)	
	1.4	Introduction to plant tissue culture: <ul style="list-style-type: none"> ○ Laboratory organization and techniques in plant tissue culture. ○ Totipotency. ○ Organogenesis. ○ Organ culture – Root cultures, Meristem cultures, Anther and Pollen culture, Embryo culture. 	
Unit II	Economic Botany and Horticulture		15 Lectures
	2.1	Economic Botany: Introduction to different categories of economically important plants with their general market importance - Cereals, Millets, Pulses, Oil seeds, Spices and Condiments, Narcotic crops.	
	2.2	Horticulture: Definition, importance and branches.	
	2.3	Introduction and Importance of Commercial cultivation: Fruits, Vegetable, Medicinal plants and Aromatic plants.	
	2.4	Greenhouse technology: Concept, Types of greenhouses, Greenhouse operation	

**SEMESTER IV
BOTANY PRACTICAL-4**

PROGRAM: S. Y. BSc.		SEMESTER: IV	
Course: BOTANY MAJOR PRACTICAL- 4		Course Code: WSBOTMJ243	
Credit Scheme		Evaluation Scheme	
Practical (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
4	2	40	60

Course Code	Course Title	Credit 2
WSBOTMJ243	BOTANY PRACTICAL- 4 (Part-A)	
Plant Genetics and Physiology		
1	Study of basic plant breeding techniques - Emasculation, Bagging and Tagging	
2	Effect of Chemical mutagens PDB/Colchicine in root tips in suitable plant material.	
3	Problems based on Polyploidy	
4	Estimation of Chlorophyll-a, Chlorophyll-b, Total chlorophyll and carotenoids content using spectrophotometric method.	
5	Study of Hill's Reaction using DCPIP reagent	
Plant Ecology		
6	Mechanical analysis of soil by the sieve method & pH of soil.	
7	Quantitative estimation of organic matter of the soil by Walkley and Blacks Rapid titration method.	
8	Identification of the stages/seres of succession- Hydrosere/Xerosere.	

Field Visit (Long Excursion)- 1		
BOTANY PRACTICAL- 4 (Part- B)		
Industrial Botany		
1	Study of activity of enzyme Lipase-	Method
2	Preparation of Herbal Tea	
3	Sterilization techniques and Preparation of growth media in PTC	
4	Callus induction using meristem culture	
Economic Botany and Horticulture		
5	Identification and Description of Economically Important Crops	
6	Cultivation of Leafy/ Salad Vegetables- Microgreens	
7	Extraction of Aromatic oil from <i>Citronella/ Patchouli</i>	
8	Study of types of greenhouse using images	
Industrial/ Institutional Visit- 1		

**SEMESTER IV
MINOR THEORY**

PROGRAM: S. Y. B. Sc		SEMESTER: IV	
Course: Plant Functions and Applications		Course Code: WSBOTMN241	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
2	2	40	60

Learning Objectives

The specific objectives of this course are:

1. To Introduce the concept and history of biodiversity
2. To study the status, importance and levels of biodiversity
3. To make students aware of the threats and conservation of biodiversity.
3. To introduce the provisions of the Biodiversity Act and the concept of a Red Data Book.
4. To learn the process of photosynthesis and special adaptive features of the plants w. r. t. various photosynthetic pathways.
5. To learn the structural chromosomal aberrations and their causes
6. To study determination of sex in plants using representatives of plant groups.

Course Outcomes

The learners will be able to:

CO1- Describe the concept, history and importance of biodiversity.

CO2- Compare the levels of biodiversity.

CO3- Analyze the threats to biodiversity and significance of conservation of biodiversity.

CO4 -Explain the Biodiversity Act and importance of the Red Data Book.

CO5- Describe various pathways involved in photosynthesis.

CO6 -Characterise structural chromosomal aberrations.

CO7 - Identify and analyze different types of sex determination in plants.

Course Title		Plant Functions and Applications	2 Credits
Course Code		WSBOTMN241	
Unit I	Ecology and Environmental Botany		15 Lectures
	1.1	Biodiversity: Introduction to Biodiversity	
	1.2	Importance of Biodiversity	
	1.3	Status of Biodiversity in India	
	1.4	Levels of Biodiversity	
	1.5	Threat to Biodiversity	
	1.6	Conservation of Biodiversity- <i>in situ</i> and <i>ex-situ</i>	
	1.7	Critical review of plants in Red Data Book	
	1.8	Biodiversity Act, 2002- Important provisions	
Unit II	Plant Physiology and Genetics		15 Lectures
	2.1	Photosynthesis: Two pigment systems, Light dependent reaction, photophosphorylation, Carbon assimilation pathways: C3 cycle, Photorespiration, C4 cycle and CAM cycle.	

	2.2	Variation in Chromosome structure (Chromosomal Aberrations): Definition, Origin, Cytological and Genetic Effects of the following: Deletions, Duplications, Inversions and Translocations.	
	2.3	Sex determination: Chromosomal Methods: heterogametic males and heterogametic females. Sex determination in monoecious and dioecious plants. Genic Balance Theory of sex determination in <i>Drosophila</i> , Lyon's Hypothesis of X chromosome inactivation.	

**SEMESTER IV
BOTANY MINOR PRACTICAL- 4**

PROGRAM: S. Y. BSc.		SEMESTER: IV	
Course: BOTANY MINOR PRACTICAL- 4		Course Code: WSBOTMN242	
Credit Scheme		Evaluation Scheme	
Practical (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
4	2	40	60

Course Code	Course Title	Credit
WSBOTMN242	BOTANY MINOR PRACTICAL- 4	2
Ecology and Environmental Botany		
1	Study of Biodiversity index (Simpson's Index)	
2	Mapping of tree diversity of Wilson College	
3	A visit and report writing on <i>ex-situ</i> Conservation Model- Veermata Jijabai Bhosale Botanical Garden	
4	Identification of plants listed under IUCN categories	
5	Study of pollen diversity with the help of Plate exposure method	
6	Field Visit (Biodiversity rich area)- 1	
Plant Physiology and Genetics		

7	Estimation of Photosynthetic pigments(Chl-a, Chl-b, Total Chlorophyll and Carotenoid)
8	Study of Hill's Reaction using DCPIP reagent
9	Study of Absorption spectrum of photosynthetic pigments
10	Study of Kranz anatomy- Leaf section of a member from Poaceae
11	Study of structural chromosomal aberrations using Photomicrograph
12	Study of Abnormal Karyotypes
13	Industrial/Institutional visit- 1

References for Semester IV

1. Introductory Plant Physiology (Second Edition) by Noggle G R and Fritz G J: Prentice Hall of India Pvt Ltd- New Delhi.
2. A textbook of Plant Physiology, Biochemistry and Biotechnology. (Revised Edition) by Verma S K and Verma M :S. Chand and Company Ltd. New Delhi
3. Plant Physiology (Revised Edition) by Mukherji S and Ghosh A K: New Central Book Agency Kolkata
4. Thacker, C. (1985). *The history of gardens*. Univ of California Press.
5. Stewart Jr, C. N. (Ed.). (2016). *Plant biotechnology and genetics: principles, techniques, and applications*. John Wiley & Sons
6. Panda, H. (2011). *The Complete Book on Wine Production*, Niir Project Consultancy Services.
7. Economic Botany by Robert Hill
8. Horticulture: Principles and Practices by George Acquaah, Pearson Edition.

SEMESTER IV

Modality of Assessment

(For Botany Major and Minor Courses)

Theory Examination Pattern:

C. Internal Assessment- (40%)- 40 Marks per course

Sr. No.	Evaluation Type	Marks
1.	Written Objective Examination	20
2.	Assignment/ Case study/ Field visit report/ Presentation/ Project/ Theme based photography/Open Book Test	20
	Total	40

D. External Examination- (60%) - 60 Marks per course

Semester End Theory Examination:

1. Duration - This examination shall be of **two hours** duration.
2. Theory question paper pattern: All questions shall be compulsory with internal choice within the

questions given as below.

Paper Pattern:

Question	Options	Marks	QuestionsBased on
Q 1.1 Descriptive	100%	10+10	Unit I
Q1.2 Short Notes	100%	5+5	
Q 1.1 Descriptive	100%	10+10	Unit II
Q1. 2 Short Notes	100%	5 + 5	
	TOTAL	60	

Examination Pattern for Major and Minor Practicals:

B. Internal Examination: (40%)- 20 Marks

Particulars	Practical Course: Major/Minor
Journal	5
Experimental tasks	10
Participation	5
Total	20

B. External Examination: (60%)- 30 Marks

Semester End Practical Examination:

Particulars	Practical Course: Major/Minor
Laboratory work	24
Spots/Viva	6
Total	30

PRACTICAL BOOK/JOURNAL- CERTIFICATION RULES

- The students are required to perform 75% of the Practical for the journal to be duly certified.
- The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

SEMESTER IV

PROGRAM(s): S. Y. B. Sc			SEMESTER: IV	
Course: Ethnobotany			Course Code: WSBOTOE241	
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Assessment 60 Marks
2	NA	NA	2	2 Assignments of 30 marks each (Total 60 Marks)
Learning Objectives				
The specific objectives of this course are to expose students to the following topics: <ol style="list-style-type: none"> 1. To learn traditional cultural practices of Indian people. 2. To learn the value of hidden knowledge about plants and their various uses. 				
Course Outcome				
The learners will be able to: <ul style="list-style-type: none"> CO 1- Examine the role of Ethnobotany in conservation and domestication of plants CO 2- Analyze various agricultural practices followed by the different tribal communities. CO 3- Appraise the importance of Sacred Groves CO 4- Evaluate the importance of Ethnobotany of some plants. 				

OE: Ethnobotany

Course Title		Ethnobotany	2 Credits
Course Code		WABOTOE241	
Unit I	1.1	Definition, Branches and Importance of Ethnobotany	15 Lectures
	1.2	Ethnic groups of India: Major and Minor Tribes, Conservation Practices of Biodiversity	
	1.3	Tribal Agricultural Practices	
	1.4	Role of Ethnobotany in Domestication of Genetic Resources	
	1.5	The Livelihood of Tribals and Forest Management	
	2.1	Sacred Groves	
2.2	Woman and Tree Motifs		
2.3	Study of Ethnobotany of Some Plants 1. Aghadha 2. Bel 3. Adulsa 4. Limba 5. Palas		
2.4	Threats to Tribal Life Style and Culture		

References for Ethnobotany

1. A. D'Rozarion, S. Bera and D. Mukherji (1999). A hand book of Ethnobotany, Kalyani Publishers. ISBN:81-7663-338-0
2. S.K. Jain (2004). A manual of Ethnobotany, 2nd Edition, Scientific Publishers, Jodhpur, ISBN: 81-7233-363-3.
3. Gadgil, M. and Vartak, V.D. (1981). Sacred groves of Maharashtra inventory. In: *Glimpses of Indian Ethnobotany* (Ed.) Jain, S.K. 279-294
4. Arora, R.K. (1981). Native food plants of the northern eastern tribals. In: *Glimpses of Indian Ethnobotany* (Ed.) Jain, S.K. 91-106. Oxford and IBH, New Delhi

SEMESTER IV OE- Medicinal Botany

PROGRAM: S. Y. B. Sc.				SEMESTER: IV
Course: Medicinal Botany				Course Code: WSBOTOE242
Teaching Scheme				Evaluation Scheme
Lectures (Hours per week)	Practical(Hours per week)	Tutoria (Hours per week)	Credit	Two assignments (Marks- 30 + 30 = 60)
2	NA	NA	2	60

Learning Objectives

The specific objectives of this course are:

1. To study the importance of traditional medicinal plants.
2. To learn the phytochemicals present in medicinal plants.
3. To learn the different abilities of medicinal plants in curing diseases.
4. To learn the various safety measures and quality of herbal drugs.

Course Outcomes

The learners will be able to:

- CO1- Appreciate the nature of medicinal plants.
- CO2- Compare the phytochemicals of medicinal plants.
- CO3 - Identify proper herbal drugs for curing disease.
- CO5 - Analyze the chemical constituent of medicinal plants.
- CO6 - Differentiate the phytochemicals present in medicinal plants.
- CO7 - Identify the parameters for safety of using herbal drugs in India.

Course Title		Medicinal Botany	2 Credits
Course Code		WSBOTOE242	
		Exploring Medicinal Plants	
Unit I	1.1	Introduction	15 Lectures
	1.2	Scope and Importance of Medicinal Plants - Traditional, Industrial/Commercial and in research	
	1.3	Traditional medicine versus Modern Phytomedicine	
	1.4	Grandma's Pouch -Common herbs, parts used, chemical constituents and uses - Harda, Behda, Murud Sheng, Pimpli, Jesthamadh, Almond	
	1.5	Herbal drugs obtained from rhizome, stem, leaf and flower - examples from each category and describe at least one plant in detail from each category	
		Applications of Medicinal Plants	
Unit II	2.1	Plants as a source of anti-cancer agents - any two plants to be described in detail	15 Lectures
	2.2	Plants as a source of anti-diabetic agents - any two plants to be described in detail	
	2.3	Antioxidant properties of medicinal plants	
	2.4	Chemical constituents, medicinal properties and uses of the following medicinal plants- <i>Acacia catechu</i> , <i>Acorus calamus</i> , <i>Allium cepa</i> , <i>Crocus sativus</i> , <i>Linum usitatissimum</i>	
	2.5	Regulatory requirements for Herbal Medicines in India: Ensuring Quality, Safety & Efficacy	
	2.6	Future scope of medicinal plants	

Reference Books-

1. Herbal drugs: A modern approach to understand them better, Edited by Dr. Subhash C. Mandal, New Central Book Agency (P) Ltd.
2. Handbook of Ayurvedic Medicinal Plants by L.D. Kapoor, CRC Press.

SEMESTER IV

VSC - Food Processing and Preservation (Practical based)

PROGRAM): S. Y. BSc.				SEMESTER: IV	
Course: Food Processing and Preservation (Practical based)				Course Code: WSBOTVS241	
Teaching Scheme				Evaluation Scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
Nil	4	NA	2	-	60

Learning Objectives

The specific objectives of this course are:

1. To expose students to different principles, techniques/methods and requirements of food processing and preservation
2. To make students aware of different food additives, their characteristics and role
3. To train students to process and preserve food with simple and traditional technology - drying, pickling etc.
4. To train students to process and preserve food with advanced and advanced technology - canning, wining etc.
5. To arrange specific industrial visits to know the scope and importance of the food processing and preservation sector

Course outcomes

The learners will be able to

CO1- Apply knowledge of principles of food processing and preservation.

CO2- Use appropriate food additives and techniques in preparation of processed food.

CO3 - Produce the processed and preserved food from appropriate plant produce based on simple, traditional techniques.

CO5 - Explore modern and advanced techniques of food processing and preservation.

CO6 - Use modern apparatus and instruments in food processing and preservation.

CO7 - Produce the processed and preserved food from appropriate plant produce based on modern and advanced techniques.

Course Title	Food Processing and Preservation (Practical Based)	
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Course Code	WSBOTVS241		2 Credits
Part I	Basics and simple processing and preservation techniques		
	1	To understand various techniques/methods of food processing and preservation and the underlying principles behind them.	
	2	Study of utensils, apparatus, tools, instruments, machines and accessories required in food processing and preservation.	
	3	To study the kinds, characteristics and uses of food additives (coloring agents, flavoring substances, preservatives, thickeners, antioxidants, sweeteners etc.)	
	4	To prepare snack food - flakes of corns and/or other grains	
	5	To prepare rice cakes and rice milk	
	6	To prepare ready to eat breakfast cereals	
	7	To prepare chutneys- sweet, sour and spicy (mango, amla, tomato, wood apple, papaya etc.)	
	8	To prepare sauce from tomato/chili/pumpkin	
	9	To prepare cookies and/or crackers	
10	A visit to the food processing unit/industry - report to be submitted by the students.		
Part II	Advanced food processing and preservation techniques		
	1	To study cold preservation and processing with appropriate plant materials - different techniques, preparations, containers and precautions	
	2	To study food preservation by drying (artificial and sun drying methods)	
	3	To study heat preservation and processing by sterilization, pasteurization and blanching techniques	
	4	To study food processing and preservation by canning - cans/bottles/pouches/tetrapacks	
	5	To prepare jam and/or jellies from fruits	
	6	To preserve fruits and vegetables by pickling - sweet and/or sour - mango, chili, amla, lemon, etc	
	7	To study processing and preservation by fermentation technology- vinegar production	
	8	To study processing and preservation by fermentation technology - cheese production	
	9	To study processing and preservation by fermentation technology - wine production	
10	A visit to the food processing unit/industry - report to be submitted by the students.		

References:

1. Handbook on Fruits, Vegetables and Food Processing with Canning and Preservation by NIIR Board, published by Asia Pacific Business Press.
2. The Complete Technology Book on Processing, Dehydration, Canning, Preservation of Fruits and Vegetables, 3rd Edition, by NIIR Board
3. Fruit and Vegetable Preservation, 3rd Edition. by R. P. Srivastava and Sanjeev Kumar

