Academic Council Meeting No. and Date: 7 / July 06, 2023

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Syllabus for

Programme: Bachelor of Science

Specific Programme: Botany

[T.Y.B.Sc. (Botany)]

Revised under Autonomy

From academic year 2023-2024

List of Contents:

Preamble

The Department of Botany was established in June 1969. The department is dedicated to providing higher education to rural youth and offers B.Sc. M.Sc. (by research) and Ph.D. degrees in Botany. The department has so far graduated over 1500 graduates, 15 postgraduate students, and over 20 Ph.D. candidates. Alumni from this department are currently employed in a variety of professions, including banking, agriculture, medical, central and state government services, industry, and education. The majority of alumni serve as prominent experts in the fields of environmental protection, education, and industry in Maharashtra. Consulting firms in India and Maharashtra.

The Department has a sufficient amount of infrastructure, including research labs, instrumentation labs with moderate equipment, and computer labs with computers running GIS software. Internet access is made available to the students. Nearly all of the required book recommendations are in the main library. The intake capacity is 20 for B.Sc., M.Sc. by research 02 and for the Ph.D. it is 03.

A three-year degree program in Life (Plant) Sciences, the Bachelor of Science (B.Sc.) program in Botany is offered. The course's duration and syllabus are broken up into semesters. These courses have six-month semesters. This program's subjects are taught via theory lectures, hourly practicals, and tutorials for a total of 32 credits. Each semester's examination plan is broken down into smaller components, including quizzes, tutorials, vivas, assignments, seminars, sessional and end-of-semester exams, and dissertation research. It includes a broad variety of scientific fields within botany that deal with the study of both lower and higher plants.

The B.Sc. in Botany program offers papers on a wide range of plant sciences, covering both fundamental and advanced topics in Bryology, Pteridology, Gymnosperms, Plant Resource Utilization, and Angiosperms: Phylogeny & Embryology, Phycology, and Cell & Molecular Biology. Plant & Animal Biotechnology, Forestry, Comprehensive Test & Field Botany, Plant Pathology, Plant Physiology, Seminar, Research Methodology, Computational Biology & Biostatics, Genetic Engineering, Environmental Botany, Mycology, Synopsis Seminar, Biochemistry and Molecular Biology of Plants.

The Bachelor of Science in Botany program's curriculum framework aims to modernize course material and teaching to give the following generation of students a multi-discipline student-cantered and outcome-based education.

The emphasis has been on maintaining academic coherence and continuum throughout the program of study and helping build a strong foundation in the subject, ensuring a smooth transition into their careers. This is in addition to structuring the curriculum to be more in-depth, focused, and comprehensive with significant skill-set for all exit levels.

The emphasis is on reducing repetition, discouraging rote learning, and encouraging learners to approach problems critically and with an open mind.

The curriculum is based on the idea that students learn science more effectively through hands-on training, projects, field studies, industry visits, and internships rather than only in a traditional classroom setting.

This syllabus has been updated to reflect modern technology, which helps students stay up to date on cutting-edge advancements in plant sciences and fosters innovation, curiosity, and a love of learning that will serve them well in their journeys of scientific exploration and adventure after they graduate.

The objective is to provide students with comprehensive information, competencies, professional skills, and a strong, optimistic mind-set that they can use to navigate the current, difficult challenges of the job market.

The Botany curriculum serves as a road map for instructors and students as they go through the subject from the start of the first academic year to the conclusion of the third. This program covers considerably more than just the information in the course as it is described here. It is about the lifelong process of personal improvement that each student acquires from their contacts with the teachers here. On this procedure, I would like to reflect back.

As a requirement for the B.Sc. course, the projects motivate the students to conduct research. Additionally, the students are exposed to seminars, and brief training and a distinguished expert gives a guest lecture. The faculty encourages students' willingness to further their education knowledge of and interest in the topic.

Educational Scope and career options After Bachelor of Science (B.Sc.) Botany

Botany opens up a person's options for education and employment in a variety of science-related fields, including microbiology, biotechnology, and even medical technology. Any and all aspects of plants that are linked to education are covered, such as agriculture engineering, horticulture, research, etc.

After completing this course, students can pursue M.Sc. and research. There is potential for the student to have an opportunity to work in national and state governments since relevant course topics are provided. The learner also has the option of working for themselves.

Dr.V.M. Jamdhade
Chairmen BOS
& Professor and Head

Syllabus Semester -V and VI

I. **Aims of Bachelor's degree programme in Botany**

The broad aims of the bachelor's degree programme in Botany are:

- To generate an environment that supports kids' complete cognitive growth. Instead of didactic lectures on only theoretical topics, this structure encourages interaction about plants and their significance.
- To give students the most current knowledge, both theoretical and practical, in order to support their core competencies and exploration learning. According to this framework, a botany graduate would be qualified to pursue additional discipline-specific courses as well as to start a career in a related field.
- To create a responsible citizen who is capable of critical thinking and communication as well as possessing the most important property-independent knowledge.
- To make it achievable for the graduate to prepare for both national and international competitive examinations, especially the UPSC Civil Services Exam and the UGC-CSIR NET.

II. **Program Learning Outcomes**

The B.Sc. Three-year and B.Sc. (Honors) Botany degrees should be achievable for graduates.

Core competency: Students will develop fundamental skills in the subjects of botany as well as associated fields.

1. The student will be able to identify the major plant groups and contrast the characteristics of lower (such as fungus and algae) and higher (such as angiosperms and gymnosperms) plants.
2. Students will be able to describe the evolution of species as well as understand the genetic variation on the planet using the evidence-based comparative botany approach. The students will be able to discuss the various processes and functions of plants, metabolism, the ideas of genes and the genome, and how an organism's function changes at the level of its cells, tissues, and organs.
3. Students will be able to understand how different types of life adapt, evolve, and interact.
4. Students are supposed to understand how life is connected on Earth and how to trace the energy pyramids using nutrient flow.
5. Students will be able to demonstrate the experimental techniques and processes specific to their specialization in Botany focusing.

III. ***Attributes of a Botany Graduate***

1) **Analytical ability:** The ability of the students to understand research and react to practical problems will be demonstrated. Using several kinds of scientific techniques, students develop hypotheses, acquire data, and then critically evaluate that data in order to evaluate how well the study supports those hypotheses.
2) **Critical Thinking and problem-solving ability:** At the completion of this course, a deeper understanding of foundational concepts and their applications to scientific principles will be achieved. The capability to think critically and solve problems will be nurtured by the students.
3) **Digitally equipped:** Students will learn digital skills and combine important concepts with innovative tools.
4) **Ethical and Psychological strengthening:** Students will become more capable of dealing with psychological problems and will develop their moral and ethical values.
5) **Team Playe**r: To work efficiently in institutions industry, and society, students will learn teamwork.
6) **Psychological skills**: Graduates are expected to have the fundamental psychological skills required for success in modern-day society, as well as the capacity to interact effectively with fellow citizens and learners from many different kinds of socioeconomic, cultural, and educational backgrounds. Feedback loops, self-compassion, self-reflection, goal-setting, interpersonal interactions, and emotional regulation are aspects of psychological capabilities.

7) **Problem-solving**: Graduates will be expected to have multidisciplinary abilities to solve issues and philosophical viewpoints;
8) **Moral and ethical awareness**: Graduates are expected to comprehend the moral and ethical standards of both India and the rest of the world and act responsibly as citizens. They have to express their essential moral principles clearly enough to differentiate between what the Indian Constitution defines as a crime and what is illegal. Academic and research ethics should be highlighted, including fair benefit sharing, plagiarism, scientific misconduct, and different issues.
9) **Leadership readiness**: To become a more effective leader graduates must have to be familiar with the decision-making process and basic skills in leadership. Creating an objective vision and objective, acquiring the knowledge to become an innovative, motivating leader, along with additional aspects include glimpses of skills.
10) **Independent Learner**: Along with subject-specific skills, general skills, particularly in botany, would be gained as an outcome of the curriculum, preparing students for further higher education, competitive exams, and employment. A curriculum focused on learning outcomes would guarantee uniform academic standards across the nation and a more comprehensive view of their skills.

IV. Choice-based Credit and Grading System

1. The credit system will be implemented from the year 2023-2024.
2. Each student is expected to take 2.5 credits per theory paper and 1.5 credits per practical in each semester.
3. At the end of each semester, each student will be examined both in the theory and in the practicals. Similarly, the student has to appear for the internal examination of theory and practicals as per the ordinances.
4. The candidate is expected to submit a journal certified by the head of the department or institution at the time of the practical examination.
5. A candidate will not be allowed to appear for the practical examination unless he or she produces a certified journal or a certificate from the head of the institution or department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily.
6. Use of non-programmable calculators is allowed both at the theory and the practical examination.

V. **Continuous Internal Evaluation :**All course types—theory, practical, project-based, and field study—include a continuous internal evaluation. The components and their weighting may be decided by the teacher in accordance with the guidelines of the university. The internal evaluation components and their proportional weighting should be announced to the students at the start of each learning activity by the relevant teacher. One week before the finish of each semester, the results of the internal evaluation should be displayed on the notice board.

VI. BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN

K1 - Remembering; K2 - Understanding; K3 - Applying; K4 - Analyzing; K5 - Evaluating

VII. Course teaching-learning process:

1. The learning experiences gained for cognitive development in every student. The practical exercises help to develop an important aspect of the teaching-learning process.
2. The important relevant teaching and learning processes involved in this course are; Class lectures,Seminars,Group discussions and Workshops, Question framing, Short answer type questions, Long answer type questions, Objective-type questions, Multiple-choice questions, Statement, reasoning and explanation, Project-based learning, Field-based learning, Practical component and experiments, Quizzes. Presentations through Posters and Power Point

VIII. Theory:

1. Lesson plan for the week will be prepared before the commencement of the session and followed during the session.
2. The theory topics are covered in lectures with the help of both conventional (chalkboard and Charts) and modern (ICT) methods, including animations.
3. Emphasis is given on an interactive classroom environment so as to encourage to students ask questions/ doubts/ queries for clarification/explanation and discussion.
4. Students are encouraged to refer to reference books in library to inculcate reading habits for a better grasp and understanding of the subject.
5. Emphasis is given to illustrations- neat, well-labelled outlines and cellular diagrams/ flowcharts for improving creative skills and to substantiate the text content.
6. On completion of the theory syllabus, previous years' question papers are discussed so as to apprise students about the general format of semester exam question papers.

IX. Practical:

1. Practical plan for each week will be prepared before the commencement of the session and followed during the session.
2. Every practical session begins with instructions, followed by students doing table work for a detailed microscopic plant study.
3. Plant study is done using fixed plant materials, museum and herbarium specimens, photographs, and permanent slides.
4. The students are instructed about maintaining practical records, which include comments and diagrams.
5. Students are asked to submit practical records regularly, on a continuous basis, for checking.
6. On completion of the practical syllabus, Practical Exam Guidelines are discussed to apprise students about the format of the Practical exam.

X. Theory Examination Pattern:

1. Internal Assessment – 40 Marks
2. External examination – 60 Marks (Semester end theory assessment)
3. Duration - These examinations shall be of two hours duration.
4. Theory question paper pattern: Attached herewith.

XI. Practical Examination Pattern:

1. Internal Examination: There will not be any internal examination/ evaluation for practicals.
2. External (Semester end practical examination)
3. 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. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Coordinator of the department; failing which the student will not be allowed to appear for the practical examination.
4. Practical paper pattern: Attached herewith.
5. **Eligibility**: Passed 12th standard (HSC) of Maharashtra State Board / CBSE / ICSE board or any other equivalent board with Biology as one of the subjects
6. **Duration**: 3 years
7. **Mode of Conduct**: Laboratory practical / Offline lectures / online lectures.

Sem-V: Theory and Practical Content

Course Code	Unit	Title of the Unit and Paper	Credit	L/Week

		Plant Diversity-III		
BNBUSBO5T1	I	Microbiology	2.5	01
	II	Algae (Phycology)		01
	III	Fungi (Mycology)		01
	IV	Plant Pathology		01
		Plant Diversity-IV		
BNBUSBO5T2	I	Palaeobotany	2.5	01
	II	Angiosperms-I		01
	III	Plant Anatomy		01
	IV	Poisonous (Toxic) and Palynology		01
		Form and Functions- III		
BNBUSBO5T3	I	Cytology and Molecular Biology	2.5	01
	II	Plant Physiology		01
	III	Environmental Botany		01
	IV	Plant Tissue Culture		01
		Current Trends In Plant Sciences- I		
BNBUSBO5T4	I	Ethnobotany and Ethnoveterinary	2.5	01
	II	Plant Biotechnology- I		01
	III	Instrumentation		01
	IV	Pharmacognosy and Medicinal Botany		01
	Title of the Practical paper		06	P/Week
BNBUSBO5P1	Practical Based on BNBUSBO5T1 and Practical Based on BNBUSBO5T2			04 04
BNBUSBO5P2	Practical Based on BNBUSBO5T3 and Practical Based on BNBUSBO5T4			04 04

Sem-VI: Theory and Practical Content

Course Code	Unit	Title of the Unit and Paper	Credit	L/Week

		Plant Diversity-III	2.5	
BNBUSBO6T1	I	Bryophyta (Bryology)		01
	II	Pteridophyta		01
	III	Gymnosperms		01
	IV	Wild Edible Vegetables and Religious plants		01
		Plant Diversity-IV	2.5	
BNBUSBO6T2	I	Angiosperms- II		01
	II	Ecological Plant Anatomy		01
	III	Plant Embryology		01
	IV	Phytogeography, Biodiversity,Conservation		01
		Form and Functions- III	2.5	
BNBUSBO6T3	I	Plant Biochemistry		01
	II	Plant Physiology- II		01
	III	Genetics		01
	IV	Biostatistics		01
		Current Trends in Plant Sciences- I		
BNBUSBO6T4	I	Plant Biotechnology-II and Molecular Biology and Gene regulation	2.5	01
	II	Research Methodology		01
	III	Economic Botany		01
	IV	Cosmetology		01
	Title of the Practical paper		06	P/Week
BNBUSBO6P1	Practical Based on BNBUSBO6T1 and Practical Based on BNBUSBO6T2			04
				04
BNBUSBO6P2	Practical Based on BNBUSBO6T3 and Practical Based on BNBUSBO6T4			04
				04

Semester	**Semester-V: Theory, Course code: BNBUSBO5T1**
Course Title	**Plant Diversity – III**

Course objectives

1. To study the classification, distinguishing characteristics, geographic distribution, and reproductive cycle of Microbes, Algae and Fungi.
2. To recognize contribution of eminent personalities in scientific study of Microbes, Algae and Fungi
3. To identify and describe causal organism, symptoms and controlling measures of various viral and fungal diseases
4. To understand the role of microorganism in wine industry and algae aquaculture and forensic investigation
5. To gain knowledge about traditional methods of seed storage.

Course Outcomes

The students would be able to…..

1. Identify and understand the salient features of major groups of microbes, algae and fungi with a suitable example
2. Apply knowledge in identifying and controlling various viral and fungal diseases
3. Analyze microbial diversity using techniques of staining, culturing and colony characteristics.
4. Develop knowledge about wine making process, aquaculture and method of seed storage

Unit	**Total Lecture:60 +02+02=64 Credit: 2.5**	**L/Week**
I	**Microbiology**	**15**
1.1	Introduction objective and scope of Microbiology	
1.2	**Types of Microbes**: Viruses, Bacteria, Algae, Fungi, Protozoa, Mycoplasma and Actinomycetes. **Culturing:** Sterilization, media, staining, colony characters. **Pure cultures**	
1.3	Contributions made by: Antonie van Leeuwenhoek and M. W. Beijerinck, Spanish flu (causes and symptoms), Wine industry - Case study (any two), Probiotics - (any two example)	
II	**Algae (Phycology)**	***15***
2.1	**Phycology**: Introduction, objective and Scope Division Rhodophyta and Xanthophyta w.r.t Classification, General Characters of Algae, Distribution, Cell structure, pigments, reserve food, range of thallus, reproduction (asexual and sexual), Alternation of Generations and Economic Importance .	
2.2	Structure, life cycle, and systematic position of *Batrachospermum and Vaucheria*	
2.3	Contributions made by Prof. Mandayam Osuri Parthasarthy Iyengar. Algae in forensic (crime) investigation, Role of algae in aquaculture.	
III	**Fungi (**Mycology)	**15**
3.1	**Mycology:** Introduction, objective and scope, General Characters of Fungi. Classification and General characters Basidiomycetes and Deuteromycetes	
3.2	Structure, life cycle, and systematic position of *Agaricus, Puccinia*	
3.3	Contributions made by Prof.B.B.Mundkar, Mycoses of man and animals (any 5)	
IV	**Plant Pathology**	**15**
4.1	Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures of the following: Tikka disease of Ground nut: *Cercospora* ,Citrus canker – Xanthomonas sp. Leaf curl – leaf curl virus.	
4.2	Traditional Grain Storage with the help of Botanical sources.	

4.3	Study of Physical, chemical and biological control methods of plant diseases. **Plant quarantine** methods, Plant epidemist disease relation.	
	Contemporary Issues	**02**
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars – webinars for strengthening the subject matters.	
	Suggested activity: Seminar, Quiz, Debate, collection of and identification and preservation of local area bryophytes and report on it. Collection study of fresh and marine Algae available in the local area. Observation and collection of plant diseases and report on it.	**02**

Course Code: BNBUSBO5T2 **Course Title :PLANT DIVERSITY IV**	**Credits:2.5**	**No. of lectures 60**

Course objectives:

1. To gain knowledge of fossils, the process of fossilization, and the specific features of Pteridophytes' and Gymnosperms' fossil records.
2. To recognize the contribution of eminent personalities in developments of Palynology, Palaeobotany and Plant

taxonomy.
3. To learn the importance of plant anatomy with respect to anomalous secondary growth.
4. To be familiar with the basic concepts and principles of plant systematics.
5. To know about the economic importance and distinguishing characteristics of toxic plants.

Course Outcomes

The students would be able to

1. Understand the fossils with respect to kinds, processes, and records from gymnosperms and pteridophyte plants.
2. Describe normal and anomalous secondary growth in plants and their causes
3. Apply knowledge of plant systematics in identifying families and plants
4. Distinguish poisonous toxic plants on the basis of morphology
5. Evaluate pollen viability, pollen allergies and role of pollen in honey, coal and oil industry.

Unit	Title of the Unit:	L/ Week
I	**Palaeobotany**	**15**
1.1	**Palaeobotany:** Introduction, objective and scope botanical and geological aspect.	
1.2	Detailed study of the fossil forms: Pteridophyta – *Lepidodendron*; Gymnosperms - *Pentoxylon*.	
1.3	Contribution of Prof.Birbal Sahni, Birbal Sahni Institute of Palaeobotany, Lucknow. Contribution of Professor TS Mahabale Palaeobotany.BSIP. Contribution of Dr. Vijay Bedekar in Conservation of Museum and Monuments.	
II	**Angiosperms-I**	**15**
2.1	Introduction, objective and scope of Angiosperm. Morphology of Flower	
2.2	Bentham and Hooker's system of classification for flowering plants up to family with respect to the following prescribed families morphological, diagnostic, and economic importance for members of the families.Cappriadaceae,Umbelliferae,Rubiaceae ,Solanaceae ,Cucurbitaceae Poaceae	
2.3	Pioneers plant taxonomy workers in India.	
III	**Plant Anatomy**	**15**
3.1	Introduction, objective and scope, Milestones in Plant anatomy, significance, and importance of Anatomy with reference to other Branches (Cornell University - Website for anatomy)	
3.2	**Anomalous secondary growth**: Introduction. Causes of anomalous secondary growth. Anomalous secondary growth in the stems of *Salvadora, Mirabilis, Achyranthus, Dracaena* and storage roots of Radish..	
3.3	**Types of Stomata** – Anomocytic, Anisocytic, Diacytic, Paracytic, and Graminaceous	
IV	**Poisonous (Toxic) and Palynology**	**15**
4.1	Introduction, objective and scope of poisonous (Toxic) plants and Palynology.	
4,2	**Poisonous (Toxic) plants:** Morphology and Toxic substance in plants: Bead Vine, Heart of Jesus, Giant Milk- weed, Dumbcane, Rubber tree, Climbing Lily, Fishtail Palm, Scorpion's Tail, Periwinkle, Lantana, Congress grass, Yellow Oleander.	
4.3	**Palynology** - Application of Palynology in the honey industry, coal and oil exploration, Aerobiology and pollen allergies. Contribution of Prof. P.K.K.Nair in Palynology.	

	Contemporary Issues	**02**
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters.	

	Suggested activity: Seminar, quiz, debate, visit to the local area and identify the toxic plants and report on it. Herbarium local wild plants.	**02**

Course Code **BNBUSBO5T3**	Course Title **FORM AND FUNCTION- III**	Credits **2.5**	No. of lectures **60**

Course objectives:

1. To learn about different cell organelles and important processes within the cell
2. To study the ultra-structure of the nucleus & its function also the characteristics of the genetic code, transcription, and translation processes.
3. To understand water relations in plants, plant adaptations to environmental factors and distribution, bio-remedial

properties of plants and eco-friendly energies.
4. To relate various plant physiological processes involved in solute and water uptake and translocation.
5. To acquaint the students with applied aspects of plant tissue culture, especially in agriculture and crop improvement.

Course Outcomes:

The students would be able to

1. Describe ultra-structure of various cell organelles and proteins
2. Build understanding about mineral nutrition, eco-friendly energies and EIA (environment Impact Assessment)
3. Apply knowledge of Genetic code, transport mechanism, bioremediation and Phytoremediation.
4. Analyze translation in prokaryotes and translocation of sugar in plants
5. Develop Plant tissue culture technique with respect to micro-propagation of orchids, cybrids-hybrids and artificial seeds

Unit	Title of the Unit: **FORM AND FUNCTIONS- III**	L/Week
I	**Cytology and Molecular Biology**	**15**
1.1	Ultra-structure and function of nucleus (Nuclear membrane, Nuclear Pore Complex, chromatin material) Structure and function of vacuole, Structure and function of giant chromosomes.	
1.2	The genetic code: Characteristics of the genetic code, RNA Processing - Splicing (3 Types Introns), Translation in Prokaryotes.	
1.3	Types of Proteins (Fibrous Globular Proteins with minimum 6 examples)	
II	**Plant Physiology**	**15**
2.1	**Water relations:** Osmosis, Transpiration, Imbibition. **Solute transport:** Passive transport (Simple Diffusion, Facilitated Diffusion), Active transport (Primary and secondary) Transport of ions across cell (Voltage gated, Ligand gated channels).	
2.2	**Translocation of solutes:** Composition of phloem sap, Pressure flow model (Munch's hypothesis), Phloem loading and unloading, anatomy of sieve tube elements and mechanisms of sieve tube translocation.	
2.3	**Mineral Nutrition:** Essential elements**,** Role of Macro (N, P, K, Ca, Fe) and Micro (Mn, B, Cu, Zn, Mo) nutrients w.r.t physiological functions and deficiency symptoms.	
III	**Environmental Botany**	**15**
3.1	**Bio-accumulation, Bio-magnification (Case Study - DDT, Mercury)**	
3.2	**Bio-remediation:** Principles, factors responsible and microbial population in bio-remediation, methods used. **Phytoremediation**: Metals, Organic pollutants.	
3.3	**Eco Friendly energies:** Geothermal, Wind, Solar and Hydroelectric energy, Concept of **ESIA** (Environment - Social Impact Assessment) and its applications	
IV	**Plant Tissue Culture**	**15**
4.1	Aspects of Micro-propagation with reference to Floriculture: e.g. *Gerbera* and Orchid.	
4.2	Plant cell suspension cultures for the production of secondary metabolites, with special reference to Shikonin production, Stirred tank Bioreactor.	
4.3	Somatic embryogenesis (Direct, Indirect), synthetic (artificial) seeds (production and applications), Somatic hybridization (protoplast fusion, hybrid and cybrid) - Case study.	
	Contemporary Issues	**02**
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –	

	webinars for strengthening the subject matters.	
	Suggested activity: Seminar, quiz, debate, visit to instrument/tissue culture lab and report on it.Visit to Municipal Corporation dumping garden and report on it.	**02**

Course Code **BNBUSBO5T4**	Course Title **CURRENT TRENDS IN PLANT SCIENCES I**	Credits **2.5**	No. of lectures **60**

Course objectives

1. To learn the concept of Ethnobotany and Ethnoveterinary and relate their medicinal importance.
2. To study the construction and analysis of genomic, chromosomal, and cDNA libraries and analysis of genes and gene transcripts.
3. To describe the working principles and parts of a various instruments used in analysis of biological materials
4. To gain knowledge about different medicinal plants, their pharmacopoeias standards and pharmacological properties.
5. To compare gene transcripts, gene libraries and develop GM plants.

Learning Outcomes:
The students would be able to

1. Identify and describe medicinal plants used in Ethnobotany and Ethnoveterinary
2. Construct and differentiate between genomic, chromosomal, and c- DNA libraries.
3. Apply knowledge in the identification and analysis of cloned DNA or its transcripts using colony hybridization, antibody probes, southern hybridization, Autoradiography and restriction mapping.
4. Analyze biological samples using Colorimetry, spectrophotometry and chromatographic separation procedures.
5. Evaluate the active constituents of medicinal plants and its application in various disorders.

Unit	Title of the Unit: **CURRENT TRENDS IN PLANT SCIENCES I**	L/Week
I	**Ethnobotany and Ethnoveterinary**	15
1.1	**Ethnobotany**- Definition, history, sources of data and methods of study. Applications of ethnobotany w.r.t Ethno-medicines, Agriculture and Edible plants, TKDL (Traditional knowledge Digital Library)	
1.2	**Traditional medicines** used by tribals in Maharashtra towards Skin ailments: *Rubia cordfolia, Sandalwood*, Liver ailments: *Phyllanthus, Andrographis*, Wound healing and aging: *Centella, Typha, Terminalia, Tridax,* Fever: *Vitex negundo, Tinospora cordifolia* leaves and Diabetes: *Momordica charantia, Syzygium cuminii.*	
1.3	Importance of Application of ethnoveterinary medicine in India and Maharashtra. Study the following ethnoveterinary plants. *Annona squamosa*, *Azadirachta indica*, *Calotropis procera*, *Cocos nucifera*, *Curcuma longa, Ficus benghalensis ,Ficus religiosa, Musa paradisiaca,Ocimum sanctum*, *Phyllanthus amarus* and *Tagetes erecta.*	
II	**Plant Biotechnology- I**	15
2.1	Plant Genetic transformation - (Ri and Ti plasmid mediated), Construction of genomic DNA libraries, Chromosome libraries and c- DNA libraries.	
2.2	Identification of specific cloned sequences in c-DNA libraries and Genomic libraries, Analysis of genes and gene transcripts – Restriction Mapping, analysis of cloned DNA sequences. Hybridization (Southern Hybridization)	
2.3	**GM Plants -** Construction of transgene and applications w.r.t Golden Rice, Bt-Cotton, Banana Vaccine. Ethical issues.	
III	**Instrumentation**	15
3.1	Colorimetry and Spectrophotometry (Visible, UV and IR) – Instrumentation, working, principle and applications.	
3.2	**Chromatography:** Working principle, Advantages and Limitations of - Paper chromatography, HPTLC, adsorption and partition chromatography, ion exchange chromatography, molecular sieve chromatography.	
3.3	Concept of SOP and Calibration of Instruments (pH meter and Colorimeter)	
IV	**Pharmacognosy and Medicinal Botany**	15
4.1	Monographs of drugs with reference to biological sources, geographical distribution, common varieties, macro and microscopic characters, chemical constituents, therapeutic uses, adulterants *Strychnos* seeds, *Senna* leaves, Clove buds, *Allium sativum, Acorus calamus* and *Curcuma longa.*	
4.2	Introduction to Pharmacology, preclinical and clinical trials (phase I,II and III)	
4.3	Case Study of two Medicinal plants w.r.t five ailments	
	Contemporary Issues	**02**
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars	

	for strengthening the subject matters.	
	Suggested activity: Seminar, quiz, debate, visit to any tribal village and report on traditional knowledge about ethnobotany and ethnoveterinary.Collection identification of ethnobotanical source.	02

SEMESTER- V: PRACTICAL

Course Code: BNBUSBO5P1 **Course Title: PLANT DIVERSITY III**	**Credits:1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	**P/Week**
I.	**Microbiology**	
1.	Introduction to biosafety and biohazards in the laboratory.	**1**
2.	Introduction to stains, mordents, simple and differential staining techniques.	**1**
3.	Study of aeromicrobiota by petriplate exposed method: Fungal culture.	**1**
4.	Study of aeromicrobiota by petriplate exposed method: Bacterial culture	**1**

5.	To study alcoholic fermentation of sugar by microorganisms and anaerobic respiration. (Kuhn's tube)	**1**
6.	Study of the microorganism using Gram's staining (Sample - Curd)	**1**
II	**Algae**	**1**
7.	Structure, life cycle, and systematic position of *Batrachospermum*	**1**
8.	Structure, life cycle, and systematic position of *Vaucheria*	**1**
9.	Structure, life cycle, and systematic position of *Pinnularia.*	
III	**Fungi**	
10.	Structure, life cycle, and systematic position of *Agaricus*	**1**
11.	Structure, life cycle, and systematic position of *Puccinia*	**1**
12.	Study of different Mycoses of man and animals (5 as per theory)	**1**
IV	**Plant Pathology**	
13.	Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures Tikka disease of Ground nut: Cercospora	**1**
14.	Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures Citrus canker – Xanthomonas sp.	**1**
15.	Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures. Leaf curl – leaf curl virus.	**1**

Course Code: BNBUSBO5P1: Course Title: PLANT DIVERSITY IV	**Credits:1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	**P/Week**
I	**Paleobotany**	
1.	Study of the following form genera with the help of permanent slides/ photomicrograph *Lepidodendron*	**1**
2.	Study of the following form genera with the help of permanent slides/ photomicrographs. Gymnosperms – *Pentoxylon.*	**1**
II	**Angiosperms-I (Plant Taxonomy)**	
3.	Study of one plant from each of the following Angiosperm families as per Bentham and	

	Hooker's system of classification.	
4.	Morphological, diagnostic, and economic importance for members of the family. Capparidaceae.	**1**
5.	Morphological, diagnostic, and economic importance for members of the family Apiaceae (Umbelliferae).	**1**
6.	Morphological, diagnostic, and economic importance for members of the family Cucurbitaceae	
7.	Morphological, diagnostic, and economic importance for members of the family. Rubiaceae.	**1**
8.	Morphological, diagnostic, and economic importance for members of the families Solanaceae.	**1**
9.	Morphological, diagnostic, and economic importance for members of the family Commelinaceae	
10.	Morphological, diagnostic, and economic importance for members of the families Poaceae.	
11.	Identifying the genus and species of a plant with the help of Flora	**1**
III	**Plant Anatomy**	
12.	Study of anomalous secondary growth in the stems of the following plants using double staining technique *Salvadora*	**1**
13.	Study of anomalous secondary growth in the stems of the following plants using double staining technique *Mirabilis*	**1**
14.	Study of anomalous secondary growth in the stems of the following plants using double staining technique *Achyranthus*	**1**
15.	Study of anomalous secondary growth in the stems of the following plants using double staining technique *Dracaena*	**1**
16.	Study of anomalous secondary growth in the roots of Beet	**1**
17.	Study the types of stomata**-** Anomocytic, Anisocytic, Diacytic, Paracytic, and Graminaceous	**1**
IV	**Palynology and Toxic Plants**	
18.	Determination of pollen viability	**1**
19.	Pollen analysis from honey sample – uni-floral and multi-floral honey	**1**
20.	Study of pollen morphology (NPC Analysis) of the following by Chitale's Method	**1**
18.	Common name and toxic content in a plant (As per prescribed theory syllabus)	**1**

Course Code: **BNBUSBO5P2** Course Title: **FORMS AND FUNCTION: III**	**Credits:1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	**P/Week**
I	**Cytology and Molecular Biology**	
1.	Preparation of Cornoy's Fixatives and Acetocarmine stain	**1**
2.	Study of mitosis using Pre-treated root tips of *Allium* (Shifted from Sem 6)	**1**
3.	Estimation of proteins by Biuret method (Prepare standard graph) (Shifted from Sem 6)	**1**
II	**Plant Physiology -I**	
4.	Estimation of Phosphate phosphorus (Plant acid extract - 3 Tube Method)	**1**
5.	Estimation of Iron (Plant acid extract - 3 Tube Method)	**1**
III	**Environmental Botany**	

6.	Estimation in the given water sample Dissolved oxygen demand	**1**
7.	Estimation in the given water sample Biological oxygen demand	**2**
8.	Estimation in the given water sample Hardness	**1**
9.	Estimation in the given water sample Salinity	**1**
10.	Estimation in the given water sample Chlorinity	**1**
IV	**Micro propagation (Plant tissue culture)**	
11.	Preparation of specified molar, normal and stock solutions	**1**
12.	Encapsulation of axillary buds by sodium alginate method.	**1**
13.	Identification – Multiple shoot culture, hairy root culture, somatic embryogenesis, Stirred Tank Bioreactor, Hybrid-Cybrid flowchart	**1**

Course Code: BNBUSBO5P2 Course Title: CURRENT TRENDS IN PLANT SCIENCES I	**Credits:1.5**	**Practical / Week - 01 (4 Periods)**

	Name of the experiment	**P/Week**
I	**Ethnobotany and Ethnoveterinary**	
1.	History geography and Tribals of Thane district and traditional knowledge.	**1**
2.	Study of plants mentioned in theory for Ethnobotany	**1**
3.	Study of plants mentioned in theory for Ethnoveterinary	**1**
4.	Preparation of Herbal Colours using Botanical Sources.	**1**
5.	Preparation and formulation of ethnobotany and ethnoveterinary herbal drugs	**1**
II	**Biotechnology- I**	**1**
6.	Plasmid DNA isolation and Separation of DNA using AGE	**1**

7.	Study of Ri and Ti plasmid, GM plants as mentioned in theory	**1**
8.	Restriction mapping (Problems)	**1**
9.	Southern blotting (Demonstration)	**1**
III	**Instrumentation**	**1**
10.	Study of Beer Lambert's Law (Lambda-max determination)	**1**
11.	Verification of Beer Lambert's Law by Standard graph	**1**
12.	Circular Paper chromatography of Amino acids	**1**
13.	Experiment based on separation of dyes/ plant pigments using silica gel column (Demonstration)	**1**
14.	Calibration of pH meter and Colorimeter	**1**
IV	**Pharmacognosy**	**1**
15.	Macroscopic/ Microscopic characters and Chemical tests for active constituents of the *Allium sativum, Acorus calamus, Curcuma longa.*	**1**
16.	Macroscopic/ Microscopic characters and Chemical tests for active constituents of the *Senna angustifolia, Strychnos nux-vomica* and *Eugenia caryophyllata*	**1**
17.	Mounting of Oils ducts- Citrus, Eucalyptus, Murraya; Laticiferous ducts Apocynaceae and Asclepiadaceae.	**1**

SEM-V PRACTICAL PATTERN

V.P.M.'S B. N. Bandodkar College of Science, (Autonomous) Thane
(Affiliation to University of Mumbai)

Course code: BNBUSBO5P1	**Title: PLANT DIVERSITY III**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
1.	Perform the given Microbiological Experiment **'A'**	**10**
2.	Identify, Classify and Describe Specimens **B and C** Sketch neat and labelled diagrams of Morphological / Microscopical structures seen in the specimens.	**14**
3.	Identify the disease of the given specimen D, describe the symptoms and control of the causal organism.	**07**
4.	Identify and describe slides / specimens **E, F** and **G.**	**09**
5.	**Journal**	**05**
6.	**Field visit /Viva voce**	**05**
	Key-	

	A– Bacterial/ Fungal Culture/ Gram's staining & **C**– Algae and Fungi (as per theory),**D -** Fungal Disease (as per theory),**E, F** & **G**– Microbial Stain, Kuhn's Tube, Algae used in forensic investigation and aquaculture and Fungi in Mycoses.

Course code: BNBUSBO5P1	**Title: PLANT DIVERSITY IV**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
1.	Classify specimen **'A'** up to their families giving reasons. Give floral formula. Sketch neat and labelled L. S. of flower and T.S. ovary.	**10**
2.	Make a temporary double stained preparation of T.S. specimen **'B'** and comment on the type of secondary growth.	**08**
3.	Perform the Palynology experiment **'C'** allotted to you.	**06**
4.	Identify and describe slide/ specimen **'D;'E', 'F' and 'G'.**	**16**
5.	**Journal**	**05**
6.	**Field visit or Museum Visit /Viva voce**	**05**
	Key- **A**– Families of T.Y.B.Sc only ,B– Anatomy anomalous secondary growth ,**C**– As per slip **D, E, F, and G-** Fossils, Types of stomata, morphology of flower and Toxic plants (As studied in theory).	

Course code: BNBUSBO5P2	**Title: FORMS AND FUNCTION-III**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
1.	Make a squash preparation of material **'A'** and show the slide to the Examiner. / Encapsulation of axillary buds by sodium alginate method. Comment on your observations	**06**
2.	Perform the experiment **'B'** allotted to you (Physiology).	**06**
3.	Perform the experiment **'C'** allotted to you (Ecology).	**08**
4.	Calculate the of the given solution **'D'** to prepare the required solution	**06**
5.	Identify and describe slide/specimen **'E'** & **'F'**.	**06**
6.	**Journal**	**04**
7.	**Tissue culture lab visit/ Viva voce**	**04**
	Key- **A-** Mitosis of Pre-treated material / Protein estimation **B**– Physiology experiment. 3 tube method & Estimation of proteins by Biuret method (3 Tube Method) (Shifted from Sem 6)	

	C– Ecology experiment. ,**D**– Molar/Normal/Stock solution Preparation **E** & **F**– Multiple shoot culture, Hairy root culture, Somatic embryogenesis, Stirred Tank Bioreactor

Course code: BNBUSBO5P2	**Title: Current Trends in Plant Sciences – I**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
1.	Preparation of herbal colours using botanical sources./Preparation and formulation of ethnobotany and ethnoveterinary herbal drugs	**08**
2.	Isolate plasmid DNA and separate using AGE/ Beer Lambert Law Lambda Max/ Verification by Std. Graph/ Paper Chromatography of Amino Acids	**10**
3.	Describe microscopical /microscopical character with the help of neat and labelled sketches of specimens **'C'** and **'D'**. Perform the chemical test / TLC to identify the active constituents.	**14**
4.	Identify and explain the specimens/ photographs **'E' and 'F'.**	**08**
5.	Journal	**05**
6.	Field visit tribal place/Viva voce	**05**
	Key- **A-** Ethnobotany and ethnoveterinary **B**– Isolate plasmid DNA and separate using AGE./ Beer Lambert Law Lambda Max/ Verification by Std. Graph/ Paper Chromatography of Amino Acids **C - Microscopy and TLC of** *Allium sativum/ Curcuma longa,* **D - Microscopy and Chemical Tests of** *Acorus calamus/ Senna angustifolia/ Strychnos nux-vomica/ Eugenia caryophyllata* **E and F -** Restriction Mapping Problem/ Oils ducts/ pH Meter	

T.Y.B.Sc. Sem-VI Syllabus to be implemented from 2023-2024

Course Code: BNBUSBO6T1 Course Title: PLANT DIVERSITY -III	**Credits:2.5**	**No. of lectures:60**

Course objectives:

1. To understand the various kinds of plants on the surface of earth with their names, geographical distribution, habit characteristics and their economic importance.
2. To build the basic skills regarding methods of controlling plant diseases.
3. To differentiate classes of Pteridophytes It covers the origin and evolution, the economic and ecological importance of Pteridophytes
4. To understand and conceptualize the classification and life cycle of members belonging to Pteridophytes and Gymnosperms.
5. To learn about various significance of plants in religious festivals

Course outcomes:

The students would be able to:

1. Describe plants of religious and economic importance.
2. Apply the knowledge in identifying pathological symptoms in plants and suggest appropriate prophylactic measures for the same.
3. Differentiate between different classes of bryophytes and Pteridophytes and also understand their evolutionary aspect as well as ecological significance.
4. Differentiate between different genera belonging to class coniferophyta and also learn their economic significance.
5. Develop nutritional recipes on the basis of information about wild vegetables.

Unit	Title of the Unit:	L/Week
I	**Bryophyta (Bryology)**	**15**
1.1	Bryology: Introduction, objective and scope. General characters of Class Mucsi, Types of Sporophytes in Bryophyta	
1.2	Structure, life cycle, and systematic position of *Marchantia, Funaria*	
1.3	Contribution of Prof.Shiv Ram Kashyap, Uses of Bryophytes material in forensic and criminal studies. Concept of Green dating.	
II	**Pteridophyta**	15
2.1	Introduction, objective and scope of Pteridophyta. General characters Lepidophyta and Calamophyta, General characters Pteridophyta and Life cycle of *Adiantum and Marselia.*	
2.2	Economic importance of Pteridophytes. Ethnomedicinal uses of Pteridophytes, floating pteridophyte *Salvinia* fern.	
2.3	Types of Sori and Soral Arrangement in Pteridophytes. Contribution of Prof.S.S**.** Bir as the father of Pteridology.	
III	**Gymnosperms**	15
3.1	Introduction, classification by D.D. Pant, objective and scope of Gymnosperms	
3.2	*Life Cycle of Gnetum, and Ephedra.*	
3.3	Economic importance of Gymnosperms Hydrophobia of gymnosperms: Myth or reality? Folklore and symbolism.	
IV	**Wild Edible Vegetables and Religious plants**	**15**
4.1	Introduction, objective and scope of plants used in religious ceremony and festivals and Importance of wild vegetables plants.	

4.2	Wild Edible Vegetables plants: Wild plants edible plant taxonomy and uses and cultivation and uses Bharangi, Takala, Kurdu, Bamboo, Shevala,Kartoli,Raan alu, Korla, Jangli tur,gabholi, Ambada, Kamal, Aghada, Karvanda,Ghol, Hatga and Traditional recipes.	
4.3	Plants used in religion and festival ceremony- Durga Puja (7 millets), (Apta) Dasera, Diwali (Tagetus), Holy (Palas, Mango, Fig, Amaltas), Gudipadava (Neem), Makarsankrati (Sesame), Mahashivratri (Bel), Janmasthami (Drumsticks), Christmas (Aurocaria), Ganesh Chaturthi (Shami, Durva).	
	Contemporary Issues	**02**
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters.	
	Suggested activity: Seminar, quiz, debate, and visit to local vegetable market report on availability of wild vegetables. Report botanical source on religious ceremony and various festivals.	02

Course Code : BNBUSBO6T2 Course Title: Plant Diversity- IV	**Credits:2.5**	**No. of lectures:60**
Course objectives: 1. To study different systems of classification and get acquainted with recent development in the field of taxonomy. 2. To learn the relation of plant anatomy with ecology.		

3. To understand different steps involved in embryonic development in plants.
4. To gain knowledge about phyto-geography and biodiversity in detail
5. To recognize significant contribution of various eminent personalities in Taxonomy and plant embryology

Course outcomes:

The students would be able to

1. Understand plants of different families, requirements for developing botanical gardens and importance of biodiversity
2. Compare the anatomical structure of plants adapting to various ecological conditions.
3. Distinguish Geo-climatic conditions which would turn into different phytogeographical regions
4. Utilize biodiversity conservation strategies to prevent further loss and preserve the existing species for future generations.
5. Develop ecotourism industry by knowing positive and negative impact.

Unit	Title of the Unit:	L/Week
I	**Angiosperms II:**	15
1.1	Morphology of Fruits, Study of one plant from each of the following Angiosperm families as per Bentham and Hooker's system of classification. Leguminosae (Fabaceae), Combretaceae, Asclepiadaceae and Labiatae. Morphological peculiarities and economic importance of the members of the above-mentioned Angiosperm families.	
1.2	Father of Indian systematic botany (Taxonomy)- H. Santapau.	
1.3	NEERI, Maharashtra Biodiversity Conservation Board, AYUSH, Ministry of Environment, Forest and Climate Change.	
II	**Ecological Plant Anatomy**	15
2.1	Introduction, objective and scope of Ecological Anatomy	
2.2	Hydrophytes – submerged, floating, Mesophytes, Epiphytes, Xerophytes	
2.3	Ecological organizations - WWF, UNESCO, MAB, UNEP, NIE, NWDB.	
III	**Plant Embryology**	15
3.1	Introduction and Objective and scope of Plant Embryology.	
3.2	Microsporogenesis, Megasporogenesis - Development of monosporic type, examples of all embryo sacs Types of ovules, Double fertilization and its significance, Development of Dicot embryo – *Capsella*	
3.3	**Biography**: Dr.Panchanan Maheshwari: Embryologist. E. Strasburger, Prof. B. M. Johri.	
IV	**Phytogeography, Biodiversity Conservation**	15
4.1	Introduction, objective and scope of Biodiversity Conservation and Plant Geography.	
4.2	**Phytogeographical regions of India.** Definition, diversity of flora found in various forest types of India. Vegetation types of Maharashtra.	
4.3	Ramsar Site Thane, Coastal regulation zone (CRZ).Eco sensitive Zones concept. Aarogya Setu, Google Earth.	
	Contemporary Issues	

	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars – webinars for strengthening the subject matters.	**02**
	Suggested activity: Seminar, quiz, debate, visit to local area and observe the flora and fauna and report on it.Visit to any pond, forest and report on it.	**02**

Course Code : BNBUSBO6T3 Course Title: Form and Function- III	**Credits:2.5**	**No. of lectures:60**
Course objectives: 1. To get familiar with the nomenclature, classification, structures of plant biomolecules. 2. To learn about the physiological role and commercial applications of Plant Growth Hormones		

3. To study key concepts like linkage, crossing over, mutations, Ame's test and diseases caused by genetic mutations.
4. To interpret biological data using statistical tools.
5. To gain knowledge about numerous metabolic processes related to enzyme kinetics, nitrogen metabolism and carbohydrate utilization

Course outcomes

The students would be able to

1. Understand and relate various biomolecules including antioxidants and enzymes
2. Describe role of nitrates and carbohydrates in plants.
3. Build knowledge of crossing over, linkage, genetic mapping, Ame's Test and metabolic disorders.
4. Apply physiological and commercial applications of Plant Growth Regulators.
5. Analyze genetic mutations with respect to causes and consequences.
6. Develop skills of solving biological problems using bio-statistical tools.

Unit	Title of the Unit	L/Week	
I	**Plant Biochemistry**	15	
1.1	**Structure of biomolecules:** Carbohydrates (sugars, starch, cellulose, pectin, lipids (fatty acids and glycerol), proteins (amino acids)		
1.2	**Enzymes:** Nomenclature, classification, mode of action, Enzyme kinetics, Michaelis-Menten equation, competitive, non-competitive, un-competitive and allosteric inhibitors.		
1.3	Plant Antioxidants used in cosmetics (5 examples)		
II	**PLANT PHYSIOLOGY- II**	15	
2.1	**Nitrogen Metabolism:** Nitrogen cycle, root nodule formation, and leghaemoglobin, nitrogenase activity, assimilation of nitrates, (NR, NiR activity), assimilation of ammonia, (amination and transamination reactions), nitrogen assimilation and carbohydrate utilization.		
2.2	Physiological effects and commercial applications of Auxins, Gibberellins, Cytokinins and Abscisic acid.		
2.3	Case study: Breaking seed dormancy by different methods using any one example of seed.		
III	**GENETICS**	15	
3.1	**Genetic mapping in eukaryotes:** Bateson and Punnett experiment, **discovery** of genetic linkage (By Morgan), gene recombination (By single crossing over and double crossing over), construction of genetic maps (Calculation of Cross over frequency), three-point crosses and mapping chromosomes.		
3.2	**Gene mutations:** definition, types of mutations (Substitution mutation - Mis-sense, non-sense, neutral and silent; Frameshift mutations - Addition and deletion), the Ame's test.		
3.3	MicroArray - Introduction, Working Principle, Applications, Types (DNA MicroArray and Protein MicroArray)		
IV	**Biostatistics**	15	
4.1	Introduction, definition, scope and importance of bio-statistics.		
4.2	Test of significance student's *t*-test – Paired and Unpaired.		

4.3	Regression and ANOVA (one way)		
	Contemporary Issues		
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters.	**02**	
	Suggested activity: Seminar, quiz, debate, and visit to statistics lab/department. Visit to agro clinics and report on available growth regulators. Preparation any working model of genetics.	**02**	

Course Code: BNBUSBO6T4 Course Title: Current Trends in Plant Sciences -I	**Credits:2.5**	**No. of lectures:60**

Course Objectives:

1. To learn about gene regulation, DNA sequencing techniques and PCR,
2. To understand applied bio-informatics involving multiple sequence and Phylogenetic analysis
3. To acquaint students with concept of research methodology and technique of referencing and presentation
4. To gain information about the importance and applications of plants & herbs in herbal cosmetics.
5. To study extraction processes for oils and formulation of cosmetics.

Course outcomes

The students would be able to

1. Describe method of gene regulation in prokaryotes
2. Apply gene sequencing and PCR techniques in recombinant DNA technology.
3. Plan, design and execute research projects by applying research methodology.
4. Analyze various sequences and relate to phylogeny of an organism
5. Develop skill of extraction of oils and formulation of cosmetics.

Unit	Title of the Unit: CURRENT TRENDS IN PLANT SCIENCES I	L/Week
I	**Molecular Biology and Gene regulation**	15
1.1	**DNA sequence analysis I** – Maxam – Gilbert Method and Sanger's method, Pyro Sequencing. Polymerase Chain Reaction (PCR).	
1.2	**DNA sequence analysis II -** DNA bar-coding **-** Basic features, nuclear genome sequence, *rbc*L gene sequence, *mat* K gene sequence, Multiple sequence analysis and phylogenetic analysis.	
1.3	Gene regulation - Concept of Operon, Lac operon and Trp Operon Mechanisms	
II	**Research Methodology**	15
2.1	Meaning of Research, types of research, problem definition, objectives, research questions, design and purpose.	
2.2	Presentation Skills - Oral and Poster presentation of research paper and Bibliography and Ethic in Research.	
2.3	Writing skills - Layout of project report and significance of report writing, writing of book review and research paper. APA, MLA, Shodhganga, INFLIBNET, Plagiarism. Impact factor.UGC Care Journal and referred.	
III	**Economic Botany**	15
3.1	Introduction, definition, scope and importance of economic Botany	
3.2	Essential Oils: Extraction, perfumes, perfume oils, oil of Rose, Sandalwood, Patchouli, Champaca, grass oils: Citronella, Drying oil (Linseed and Soybean oil), semi-drying oils (Cotton seed, Sesame oil) and non-drying oils (Olive oil and Peanut oil)	
3.3	Vegetable Fats: Coconut and Palm oil	
IV	**Cosmetology**	15
4.1	**Introduction to Herbal Cosmetics w.r.t.** Definition, current status of herbal cosmetics industry in India, problems and future prospects of herbal cosmetics Industry in India	
4.2	**Standardization of raw material** - Importance of raw materials, collection and processing of herbal drugs, natural and artificial drying of plant materials physical and chemical methods of standardization, qualitative and quantitative estimations phytoconstituents	
4.3	**Applications of herbs in the following herbal cosmetics -** Herbal shampoo, Herbal hair dye, Herbal hair oil, Herbal hair cream, herbal hair gel, herbal face mask and herbal bath oil.	
	Contemporary Issues	

	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, online seminars –webinars for strengthening the subject matters.	**02**
	Suggested activity: Seminar, quiz, debate, maintaining a laboratory record; Tabulation and generation of graphs. Visit to Library gathered information from Librarian regarding Reference book, online data available. Visit to cosmetics shops/beauty salon and report on available cosmetics and satisfaction index. Visit to any small scale industry and report on it.	**02**

Practical Sem-VI

Paper-1

Course Code: BNBUSBO6P4 Course Title: PLANT DIVERSITY -III	**Credits** **1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	P/Week
I	**Bryophyta (Bryology)**	
1.	Study of stages in the life cycle of the following Bryophyta from fresh / preserved material and permanent slides *Marchantia, Pelia,Funaria*	**2**
2.	Economic importance of Bryophyta	
3.	Types of Sporophyte s in Bryophyta (from permanent slides)	**1**
II	**Pteridophyta**	
4.	Study of stages in the life cycles of the following Pteridophytes from fresh / preserved material and permanent slides *Adiantum*	**2**
5.	Study of stages in the life cycles of the following Pteridophytes from fresh / preserved material and permanent slides *Marselia.*	**2**
6.	Study of stages in the life cycles of the following Pteridophytes from fresh / preserved material and permanent slides *Lycopodium/Equisetum*	**1**
7.	Economic importance of Pteridophyta	**1**
8.	Types of Sori and Soral Arrangement in Pteridophytes	**1**
III	**Gymnosperms**	
9.	Study of stages in the life cycles of the following Gymnosperms from fresh / preserved material and permanent slides *Gnetum*	**1**
10.	Study of stages in the life cycles of the following Gymnosperms from fresh / preserved material and permanent slides *Ephedra*	**1**
IV	**Applied aspects of Botany**	
11.	Identification of wild edible vegetables plants (As per the theory) and use factor and fidelity level as per theory.	**1**
16.	Identification of religious and festivals plants used in Thane district (As per the theory)	**1**

Course Code: BNBUSBO6P4 Course Title: PLANT DIVERSITY-IV	**Credits 1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	
I	Study of one plant from each of the following Angiosperm families as per Bentham and Hooker's system of classification. Morphological peculiarities and economic importance of the members of the above mentioned Angiosperm families.	

1.	Leguminosae (Fabaceae)-Subfamilies – Papilionaceae	**1**
2.	Leguminosae (Fabaceae)-Subfamilies –Caesalpiniaceae	**1**
3.	Leguminosae (Fabaceae)-Subfamilies –Mimoseae	**1**
4.	Combretaceae	**1**
5.	Asclepiadaceae	**1**
6.	Labiatae-Lamiaceae	**1**
7.	Morphology of Fruits	1
8.	Identification of Genus and Species	1
II	**Study of Ecological Anatomy**	
9.	Hydrophytes – submerged, floating	**1**
10.	Mesophytes	**1**
11.	Epiphytes	**1**
12.	Xerophytes/halophytes	**1**
III	Plant Embryology	
13.	Mounting of Monocot (Maize) and Dicot (Castor and Gram) embryo	**1**
14.	*in vivo* growth of pollen tube in *Portulaca/Vinca*	**1**
15.	Study of various stages of Microsporogenesis, Megasporogenesis and Embryo Development with the help of permanent slides / photomicrographs	**1**
IV	**Plant Geography**	
16.	To study Simson Diversity Index	1
17.	Preparation of vegetation map using Garmin's GPS Instrument	1
18.	To Study Phyto-geographical regions of India.	1

Course Code: BNBUSBO6P5 Course Title: FORMS AND FUNCTION III	**Credits 1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	
I	**Plant Biochemistry**	
1.	Effect of temperature on the activity of amylase	**1**
2.	Effect of pH on the activity of amylase	**1**

3.	Effect of substrate variation on the activity of amylase	**1**
II	**Plant Physiology- II**	
4.	Effect of GA on seed germination	**1**
5.	Estimation of Vitamin C from the given sample	**1**
6.	Determine rate of transpiration under different conditions of Sunlight, Shade and Wind	**1**
III	**Genetics**	
7.	Problems based on three point crosses, construction of chromosome maps	**1**
11	Identification of types of mutations from given DNA sequences	**1**
12	Study of DNA and Protein Microarrays and Ame's Test	**1**
IV	**Biostatistics**	
13	*t*-test (paired and unpaired)	**2**
14	Problems based on regression analysis	**2**
15	ANOVA	**2**

Course Code: BNBUSBO6P5 Course Title CURRENT TRENDS IN PLANT SCIENCES I	**Credits 1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	
I	**Molecular Biology**	
1.	DNA sequencing by Sanger's Method	1
2.	DNA sequencing by Pyro Sequencing Method	1
3.	Demonstration of PCR	1

4.	Phylogenetic analysis	1
5.	Multiple sequence alignment	1
II	**Research Methodology**	
6.	Use of Research Resources by Mendeley	1
7.	Use of Research Resources by and Shodhganga	1
8.	Book review	1
9.	Research paper review	1
10.	Research proposal writing	1
III	**Economic Botany**	
11.	Demonstration: Extraction of essential oil using Clevenger	1
12.	Thin layer chromatography of essential oil of *Patchouli* and *Citronella*	1
13.	Saponification value of Palm oil	1
IV	**Cosmetology**	
	Preparation cum Demonstration of herbal creams, shampoo, lotions and other cosmetics	
14.	Aloe vera gel	1
15.	Hair packs	1
16.	Hair Oils	1
17.	Face packs (Pimple face pack and regular face pack)	1
18.	Herbal shampoo	1

SEM-VI PRACTICAL PATTERN

V.P.M.'S B. N. Bandodkar College of Science, (Autonomous) Thane

(Affiliation to University of Mumbai)

Course code: BNBUSBO6P4	**Title: PLANT DIVERSITY -III**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
1.	Identify, classify and describe specimen **'A'**. Sketch neat and labelled diagrams of Morphological/Microscopical structures seen in the specimens.	**07**
2.	Identify, classify and describe specimen **'B'**. Sketch neat and labelled diagrams of Morphological/Microscopical structures seen in the specimens.	**07**

3.	Identify, classify and describe specimen **'C'**. Sketch neat and labelled diagrams of Morphological/Microscopical structures seen in the specimens.	**08**
4.	Identify and describe slides/specimen **'D', 'E', 'F', 'G' 'H' and 'I'.**	**18**
5.	**Journal**	**05**
6.	**Filed visit/Viva voce**	**05**
	Key- **A -** Bryophytes: *Marchantia/ Funaria* **B -** Pteridophytes: *Adiantum/ Marsilea/Lycopodium* **C**– Gymnosperm: *Gnetum & Ephedra* **D -** Economic importance of Bryophytes, **E-** Types of Sporophyte, **F -**Economic importance of Pteridophytes **G -** Types of sori and soral arrangement in Pteridophytes, **H** - Wild vegetables, **I** - Religious and festival plants. (As in theory)	

Course code: BNBUSBO6P4	**Title: PLANT DIVERSITY -IV**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
7.	Classify specimen **'A'** up to its famil**y** giving reasons. Give floral formula. Sketch neat and labelled L.S. of flower and T.S. ovary.	**08**
8.	Identify genus and species of specimen **'B'** using flora.	**05**
9.	Make a stained preparation of specimen **'C'** and comment on its ecological anatomy.	**06**
10.	Calculate Simpson's Diversity Index from the given data **'D'**.	**05**
11.	Mark the Phytogeographical region **'E'** in the map of India and Comment on the same.	**04**
12.	Identify and describe slide/specimen **'F', 'G','H'.& 'I'**	**12**
13.	**Journal**	**05**
14.	**Field visit/Viva voce**	**05**
	Key- A– Families of T.Y.B.Sc Sem – VI only, B– Plants from F.Y., S.Y. & T.Y. B. Sc**.** (Sem – V Families to be included**)**. **C**– Ecological anatomy. **F, G, H & I**– Economic importance of specimen from prescribe families (Sem VI only)**,** Morphological Peculiarities of prescribed families (Sem – VI only), Embryology. (In random order), morphology of fruit.	

Paper-3

V.P.M.'S B. N. Bandodkar College of Science, (Autonomous) Thane
(Affiliation to University of Mumbai)

Course code: BNBUSBO6P5	**Title: Form and Function IV**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
15.	Perform the experiment **'A'** allotted to you.	**10**
16.	Perform the experiment **'B'** allotted to you.	**10**
17.	Construct a chromosome map from the given data **'C'** / Identify the type of mutation and comment on them (any two types of mutations)	**08**
18.	Identify Specimen **'D'** and comment on it	**04**

19.	From the given data/ material **'E'** determine test of significance using students t-test/ Regression Analysis /ANOVA	**10**
20.	**Journal**	**04**
21.	**Filed visit/Viva voce**	**04**
	Key- A– Plant Biochemistry Experiment. - Enzyme Kinetics, **B**– Plant Physiology Experiment. Effect of GA, Vit C estimation and Transpiration rate,C - Mapping Problem,D - Microarray/ Ame's Test,E - Biostats Problem	

Paper-4

V.P.M.'S B. N. Bandodkar College of Science, (Autonomous) Thane
(Affiliation to University of Mumbai)

Course code: BNBUSBO6P5	**Title: CURRENT TRENDS IN PLANT SCIENCES I**	**Duration:03 Hrs.**	**Max.Marks:50**

Q.	**Name of the Experiment**	**Marks**
22.	Perform DNA sequencing by Sanger's method of the given sequence **'A'** /DNA sequencing by Pyro Sequencing Method	**10**
23.	Perform the experiment economic botany **'B'** allotted to you	**08**
24.	Perform the experiment Bioinformatics **'C'** allotted to you	**07**
25.	Prepare the herbal cosmetic pickle from the given material **'D'**.	**10**
26.	Research Paper Review / Viva voce. (Based on Paper III and Paper IV)	**10**
27.	**Journal**	**05**
	Key- A - Sequencing B– TLC of *Patchouli* or *Citronella* / Saponification value, **C**– Multiple Sequence Alignment (MSA) / Phylogenetic Analysis	

Theory Examination: <u>Suggested Format of Question paper</u>

Duration: 2 Hours
All questions are compulsory **Total Marks: 60**

Q. 1	Answer ***any two*** of the following		**16**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
Q. 2	Answer ***any two*** of the following		**16**

	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
Q. 3	Answer ***any two*** of the following		**16**
	a	Based on Unit III	
	b	Based on Unit III	
	c	Based on Unit III	
	d	Based on Unit III	
Q. 4	Answer ***any two*** of the following		**12**
	a	Based on Unit I	
	b	Based on Unit II	
	c	Based on Unit III	
	d	Based on Unit I II III and IV	

** (4 questions of 8 marks each / 8 questions of 4 marks can be asked)

Evaluation Scheme Internals

Internals	**Active Participation & Leadership qualities**	**Total**
30	**10**	**40**

Curriculum and Extracurricular (30M)

Research – Presentation/ Paper review/ Book review/ Project/ Publication of Research Paper

OR

Writing skills - Essay writing/ Report on - Campus visit/ Industry Visit/ Field Trip/ Visit to a garden/ Report on Conference – Workshop – Seminar – Webinar attended/ Intercollegiate competition participation/ Science movies review/ Assignment/ Case studies on topics assigned

OR

Skill development – Flip the class/ Open Viva/ Debate/Group Discussion/ Quiz/ e-herbarium/ Photo gallery-Nature Photography, Flora & Fauna/ Botanical illustrations/ Model making/ Survey of the topic assigned

OR

Innovation: Using Plant resources/Animal resources to frame new names (Human beings), Slogan making (Use of any Language)/Construct Botanical Calendar

OR

Green Campus efforts - Raising and maintaining plant/ maintenance of the departmental garden

OR

Active participation in Departmental Club (Botany Club/ Movie & Journal Club)

OR

Class test (Sem V - Paper I, II, III, IV on 1.3, 2.3, 3.3, 4.3 of Unit I, II, III, IV) and (Sem VI - Paper I, II, III, IV on 1.3, 2.3, 3.3, 4.3 of Unit I, II, III, IV)

OR

Certification from Swayam / NPTEL (Courses in Bio-sciences), Certificate courses related to Botanical sciences (minimum 5 hours = 10 marks in only one paper)

OR

Collection of germplasm and Soil boll preparation

OR

Entrepreneurship Skill: Preparation and Trading of Mocktail/Squash/Syrup using seasonal fruits/ preserved products/ Garlands/Gajra/Bouquet/Tulsi plant/Paper bags/Paper envelope

OR

Skills and knowledge: Introduction to Basic MS-Excel/ Advanced MS-Excel /Python (minimum 5 hours = 10 marks in only one paper).

OR

Social: Visit to tribal area and report on traditional practices.

OR

Religious: Visit to religious places and report on botanical sources

OR

Plant /Animals/Birds: Pet care/Pet friend/nature lovers/Bird lovers/Friend of farmers
National integration: Blood donation,

* Note – If a candidate failed to submit assigned work in time due to genuine reason, then it can be compensated by assigning a new task for the benefit of the candidate.

Recommended Texts

1. Kokate C.K et al. 1999.Pharmacognosy, Nirali Prakashan.
2. Agarwal, K.C. 2001.Environmental Biology, Nidi Publications Ltd., Bikaner, London
3. Agashe S. N., Palaeobotany: Plants of the past, their evolution, Palaeoenvironment and application in exploration of fossil fuels, Science Publishers, 1997.
4. Agnes Arber, 1999.Herbal plants and Drugs Mangal Deep Publications.
5. Ainsworth, G.C., Sparrow, F. K. and Sussman, A. S. (1973). The Fungi. Academic Press, New York.
6. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. 4 th edition. John Wiley and Sons (Asia), Singapore.
7. Alexopoulose, C.J., Mims, C.W., Blackwell, M. (2007). Introductory Mycology. John Wiley & Sons, New York.
8. Almeda, M.R., 1996. Flora of Maharashtra. Volume-1-2.
9. Asthana, D.K. and Meera Asthana 2013 A Text book of Environmental Studies, S. Chand and Company Pvt Ltd., New Delhi.
10. Ayurvedic Pharmacopoeia of India, AYUSH, Government of India.
11. Batygina T. B. (2009). Embryology of Flowering Plants Terminology and Concepts, Volume 3, Reproductive Systems, Science Publishers, USA.
12. Bessy, E.A. (2015) Morphology and Taxonomy of Fungi. Scientific publisher-Jodhpur.
13. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms. New Age International (P) Ltd., New Delhi, India.
14. Bhatnagar, S.P., P.K. Dantu and S.S Bhojwani. (2018). The Embryology of Angiosperms, 6th Edition, Vikas Publishers House, New Delhi.
15. Bhattacharya K., M. R. Majumdar and S. G. Bhattacharya. (2006). A text Book of Palynology, New Central Book Agency (P) Ltd., Kolkata, India.
16. Bhojwani S. S. and Bhatnagar S. P. (1992). The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.
17. Bhojwani, S. S. and Razdan, M. K. (1997). Plant Tissue Culture: Theory and Practice. Springer Publishers Netherlands.
18. Bhojwani, S.S. and Bhatnagar, S.P.(1985), Embryology of Angiosperms, Vikash Publishing House, New Delhi
19. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi
20. Bilgrami S.A. and Verma R.N. (1990). A Textbook of Modern Plant Pathology. Vikas Publishing House Pvt. Ltd.
21. Biswas C. and Johri B.M. - The Gymnosperms Springer publication
22. Biswas S., Datta M., Mushroom: A Manual for Cultivation, College of Agriculture, Phi learning Pvt. ltd., 2011.
23. Bold H.C. and Wynne M.J. (1985). Introduction to the algae; Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey.
24. Buchanan B.B., Gruissen W. and Jones R.L. (2nd Ed) (2015) Biochemistry and Molecular Biology of Plants, ASPP.
25. Cain, S.A. 1944. Foundations of Geography, Harper and Bros. New York. 6. Good, R.D. 1974. The Geography of Flowering Plants. 3 edition. Long Mans, London.
26. Cavers, F. (1976). The inter relationships of the bryophyte. S.R. Technic, Ashok Rajpath, Patna.
27. Chapman V.J. and Chapman D.J. (1975). The algae, 2nd Edition, Mac. Millan Publ. Inc. New York.
28. Chaudhuri, Rai H.N. & D.C. Pal 1981. Plants in folk religion and mythology. In: S.K. Jain (ed.), Glimpses of Indian Ethnobotany. Oxfords IBH, New Delhi. 59- 68.
29. Chhaya Biswas and B.M.Johri. The Gymnosperm. Springer; 1997, edition (16 April 2014)
30. Chopra G. L., Angiosperms: Systematic & Life cycle, Nagin & Co. 1964
31. Chopra R.N, S.L.Nayar and I.C.Chopra, 1956.Glossary of Indian medicinal plants,. C.S.I.R, New Delhi.
32. Chopra, G.L. (1998). A text book of Fungi. S. Nagin & Co. Meerut.
33. Chopra, R. N., and Kumar P. K. (1988). Biology of Bryophytes. John Wiley and Sons, New York, NY.
34. Cooke, T., 1967. The Flora of the Presidency of Bombay. Vol. I, II, III. Botanical Survey of India. Calcutta.
35. De Robertis E. D. P., Cell Biology and Molecular Biology, 8th edition, Lea and Febinger, 1987.

36. De Robertis E. D. P., Saez F. A. & De Robertis E.M.F.,Cell Biology, Saunders, 1975
37. Dube, H.C. (1996). An Introduction to Fungi. Vikas Publishing House, New Delhi.
38. Dubey, R. C. (2009). A text book of Biotechnology. S. Chand & Co. Ltd. New Delhi.
39. Dubey, R. C. and Maheswari, D. K. (2010). A Text book of Microbiology, S. Chand & Company, New Delhi.
40. Eames, A.J. (1936) Morphology of Vascular plant-lower group. Tata Mc Graw Hill, New Delhi. Chamberlain, Charles Joseph, b.(1863), Gymnosperm; Structure and Evolution. Chicago, III., The University of Chicago Press
41. Esau K. (1985). Plant anatomy, 2nd Edition, Wiley Eastern Limited, New Delhi.
42. Evans W. C., Trease and Evans Pharmacognosy, 16th edition, Saunders ltd., 2009.
43. Fahn A., Plant anatomy, Pergamon Press,1967
44. Gangulee H.C., Das K.S., &Datta C., College Botany, Volume II, New Central Book Agency, 2006
45. Gangulee, Das & Datta, College Botany, Volume II, New Central Book Agency, 2006
46. Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K., 2002. An Introduction to Research Methodology, RBSAPublishers
47. Glick B.R., Pasternack J., Patten C., Molecular Biotechnology Principles and Applications of Recombinant DNA Technology 4th edition , American Society of Microbiology.
48. Glick, B. R., Pasternak, J. J. & Patten C. L.: Molecular Biotechnology Principles and applications of Recombinant DNA 4 thEdition Wiley Publishers 2010
49. Gopalakrishnan N.S. & Agitha T.G., Principles of Intellectual Property (2009), Eastern Book Company, Lucknow
50. Gupta A.K and Neeraj Tandon- Reviews on Indian Medicinal Plants Indian Council of Medical Research (ICMR) 2004.
51. Gupta, P. K. (2000). Cytology, Genetics and Evolution. 6th edition. Rastogi Publications, Meerut
52. Gurcharan S., Plant systematics, Oxford &IBH publishing Co. Pvt. Ltd., 3rd edition, 2012
53. Ignacimuthu S., Plant Biotechnology, 2nd edition, Narosa Publishing HsePvt. L 2012.
54. Jain S. K. & Mudgal V., A Handbook Of Ethnobotany, Bishen Singh Mahendra Pal Singh, Debra Dun, 1999
55. Jain S.K. (1997). Contribution to Indian Ethnobotany, Sci. Publ. Jodhpur
56. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
57. Jain, S. K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow 12.
58. Jain, S. K. (1995). A manual of Ethnobotany. Scientific Publishers, Jodhpur.
59. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. and Das, D. (1984). Bibliography of Ethnobotany. Botanical Survey of India, Howrah
60. Jain, S. V. (2021). Applied Ecology and Sustainable Environment. BFC Publications.
61. Jain, S.K. and R.R. Rao. (1977). A handbook of Field and Herbarium methods. Today and Tomorrow Printers and Publishers, New Delhi.
62. Jamdhade V.M. 2022. Wild Edible Plants Used by the Tribes of Panvel and Uran Tahsils in Alibaugh District, India: Ethnobotanical Application and Tribal Recipes Journal of Botanical Research | Volume 04 | Issue 01 | January 2022.
63. Jayaraman, J. (2011) Laboratory Manual in Biochemistry. John Wiley and Sons Ltd
64. Jha T. B., Ghosh B., Plant tissue culture- Basic and Applied, Universities Press, 2005.
65. Johri B.M. (1984). Comparative Embryology of Angiosperms, Ind. Nat. Sci. Acad., New Delhi
66. Johri, B.M (1984) Embryology of Angiosperms.Springer-Verlog Berlin Heidelberg.
67. Johri, R.M., Lata, S. and Tyagi, K. (2012). A Textbook of Bryophyta. Dominant Publishers &. Distributors Pvt., Ltd., New Delhi.
68. Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi
69. Joshua O.Miluwi and Hina Rashid .Research Methodology: Principle, Methods and Practices
70. Kannaiyan S & K.Ramasamy (1980).A hand book of edible mushroom, Today & Tomorrows printers & publishers, New Delhi
71. Kanny, Lall, Dey and Raj Bahadur, 1984.The indigenous drugs of India,. International Book Distributors.
72. Kashyap S. R. 1972, Liverworts of the Western Himalayas & the Punjab Plains. Part 1 & 2.

73. Kashyap, Shiv Ram (1929). Liverworts of The Western Himalayas and The Punjab Plain Part 1 Chronica Botanica, New Delhi.
74. Kashyap, Shiv Ram, (1932). Liverworts of the western Himalayas and the Punjab plain (illustrated): Part 2. The Chronica Botanica New Delhi.
75. Khandelwal K.R., Practical Pharmacognosy- techniques and experiments, Nirali Prakashan, 2008.
76. Kokate C. K., Purohit A. P., Pharmacognosy, NiraliPrakashan, 2011.
77. Kothari C. R., Research methodology – Methods and Techniques (Second Revised Edition) New Age International Publishers, 2004.
78. Kothari C. R., 1990. Research Methodology: Methods and Techniques New Age International418p.
79. Kumar, H. D. and Swati Kumar (1999). Modern concepts of Microbiology, Vikas Publishing House, New Delhi.
80. Kumar, H.D. (2005). Agricultural Biotechnology. Daya Publishing House.
81. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
82. Lawerence G.H.M, 1951. Taxonomy of Vascular plants, Oxford & IBH publication, New Delhi.
83. Mahajan B.K., Methods in Biostatistics: For medical students and research workers, Jaytee Medical Publishers, 2008
84. Mahajan B.K., Methods in Biostatistics: For medical students and research workers, Jaypee Brothers Medical publishers, 2008.
85. Maheshwari P. (1985). An Introduction to Embryology of Angiosperms, Tata McGraw Hill, New Delhi.
86. Maheshwari, P. (1950) An Introduction to the Embryology of Angiosperms.Tata McGraw Hill.
87. Mathias E. 2001. Introducing ethnoveterinary medicine.www.ethnovetweb.com
88. Mathias, E. 2007. Ethnoveterinary medicine in the era of evidence-based medicine: mumbo-jumbo, or a valuable resource? The Veterinary Journal173: 241-242
89. McCorkle C M. 1998. Ethnoveterinary Medicine: Ethnoscience or just Anti-Science? In: Complementary and Alternative Veterinary Medicine: Principles and Practice. (Schoen A M and Wynn S G (editors)) Mosby, St. Louis.
90. McCorkle C M.1986. An introduction to ethnoveterinary research and development. Journal of Ethnobiology 6: 129-149
91. Mishra SR (2010) Plant Biochemistry.Discovery Publishing House Pvt. Ltd., New Delhi.
92. Mishra SR (2011) Understanding Plant Biochemistry. Discovery Publishing House Pvt. Ltd., New Delhi.
93. Mushroom Production and Processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
94. Naik, V.K.1984. Principles and trends in the taxonomy of angiosperms. Tata McGraw-Hill Co. Ltd., New Delhi.
95. Naik, V.N., 1998. Marathwadyatil Samanya Vanaushhadhi (Marathi). Amrut Prakashan, Aurangabad.
96. Nair P.K.K. (1985). Essentials of Palynology, Asha Publishing House, New York.
97. Nita Bahl, .Handbook on Mushrooms, oxford & IBH Publishing Co.
98. Odum E. P., Barrett G. W., Principles of Ecology, Brooks and Cole, 2004.
99. Odum, E. P. 1971.Fundamentals of Plant Ecology. W. B. Snderson Co., Philadelphia
100. P S S Sunder Rao Introduction to Biostatistics and Research Methods
101. Pandey and Misra 2008. Taxonomy of Angiosperms: Ane Books Pvt Ltd,New Delhi
102. Pandey B. P., Plant anatomy, S. Chand & Co. Ltd., 2012
103. Pandey, B.P. (1992). Economic Botany. (S. Chand and Sons Co., New Delhi)
104. Pandey, B.P., Angiosperms-Taxonomy, Emrbyology and Anatomy, S. Chand and Co., New Delhi
105. Pandey, B.P.2014.Economic Botany,S.Chand and Company Pvt.ltd., New Delhi.
106. Pandey, P.B. 2014. College Botany- 1: Including Algae, Fungi, Lichens, Bacteria, Viruses,
107. Pant DD. (2002), An Introduction to Gymnosperms, Cycas, and Cycadales, Birbal Sahni Institute of Palaeobotany
108. Pant, K., 1996. Nutritive values of some non-conventional vegetables used in tribal area of Thane district M.Sc. Thesis Bombay University.
109. Parihar N. S. 1965, An Introduction to Embyophyta- Bryophyta. Central Book Depot. Allahabad.
110. Parihar, N.S. (1980). Bryophytes: An introduction to Embryophyta Vol I Bryophyta. Central Book Depot.

111. Parihar, N.S. 1991. An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
112. Pelczar .Microbiology Published by Tata McGraw-Hill, 1998.
113. Pijush R., Plant anatomy, New Central Book Agency, 2006
114. Plummer, D. T. 1988. An Introduction to Practical Biochemistry. Tata Mc Graw – Hill Pub. Co., Ltd., New Delhi.
115. Powar, C.B. and Daginawala, H.F. (1982). General Microbiology Vol.II. Himalaya Publishers, Bombay.
116. Pullaiah, T. 1998. Taxonomy of Angiosperms. Regency Publications, New Delhi.
117. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
118. Ranjeet Kumar .Research Methodology: A Step By Step Guide for beginners
119. Rao, A.S. (2001). Introduction to Microbiology. Prentice Hall of India, New Delhi.
120. Rashid, A, 2011, An Introduction to Pteridopyta, 2nd edition, (Reprint), Pub. Vikas Publishing House Pvt. Ltd., Noida
121. Roig, M.. Avoiding plagiarism, self-plagiarism, and other questionable writing practices: A guide to ethical writing. U.S. Department of Health & Human Services: Office of Research Integrity. (2011)
122. Russell P. J., Genetics: A Mendelian Approach, 3rd edition, Pearson Education India, 2009.
123. Russell P., I Genetics: A Molecular Approach, Pearson Education, 3rd Edition, 2011
124. Salisbury, F.B. and Ross, C.W. (1991) Plant physiology. (4th Ed), Wadsworth Publishing Company, Beverly.
125. Sambamurthy. A.V.S.S.2005.Taxonomy of Angiosperms, IK International publishers, New Delhi
126. Sanjeev Kumar, Recent Advances In Ethnobotany, Deep publication 2015
127. Shah, G.L., 1978. Flora of Gujarat state Saradar Patel University, V.V Nagar Gujarat.
128. Sharma O. P., 2011. ALGAE Published by Tata McGraw Hill Education Pvt. Ltd. New Delhi.
129. Sharma O. P., Plant Taxonomy, Tata McGraw – Hill Publishing Co. Ltd., 2009
130. Sharma, O.P. 2011. Fungi and Allied Microorganisms, McGraw Hill Publishing Company Limited, New Delhi.
131. Sharma. P. D. 1993. Ecology and Environment, Rastogi Pub., New Delhi
132. Simpson, M.G. 2006. Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
133. Singh B.D., Biotechnology – Expanding horizons, Kalyani Publications, 2009
134. Singh Gurucharan, Plant systematics, Oxford & IBH publishing Co. Pvt. Ltd., 3 rdedition, 2012
135. Singh, G. (2009). Plant systematics: an integrated approach. Science Pub Inc.
136. Singh, G. 2012. Plant Systematics: Theory and Practice. 3 rd edition. Oxford & IBH Pvt. Ltd., New Delhi.
137. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae+Fungi+Brophyta+Pteridophyta) , Pub. Rastogi Publication, Meerut
138. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication,Meerut.
139. Sinha S. C. and Dhiman A. K., 2002. Research Methodology Ess Publications 2 Columes.
140. Sinha, U and S. Sinha (1989) Cytogenetics, Plant Breeding and Evolution. Vikas Publishing House Pvt. Ltd. New Delhi.
141. Sivanna K.R., &Johri B.M., Angiosperm Pollen: Structure and Function, John Wiley & Sons (Asia), Pvt. Ltd , 1986
142. Smith, G.M. 1955. Cryptogamic Botany. Vol. II. Bryophytes and Pteridophytes. 2 nd edition. McGraw-Hill, New York.
143. Stuart Melville and Wayne .Research Methodology: An Introduction
144. Sundara Rajan S. College Botany Vol III Himalaya Publisherws.
145. Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers.
146. Taiz L. & Zeiger E., Plant Physiology, Sinauer Associates, 2010
147. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
148. Trochim W. M. K., 2005. Research Methods: The Concise Knowledge Base Atomic Dog Publishing.270P
149. Udar, R. (1970). Introduction Bryophyta Shashidhar Malaviya Prakashan, Lucknow.
150. Udar, R. (1976). Bryology in India: Chronica Botanica, New Delhi.
151. Vashishta, B.R. and Sinha, A.K. 2014. Botany for Degree Students: Fungi. S. Chand & Company Pvt. Ltd., New Delhi.
152. Veerakumari L., Bioinstrumentation, MJP Publishers, 2004.

153. Verma P. S., Agarwal V.K., Textbook of Environmental Biology, S. Chand, 2000.
154. Verma P.S. & Agarwal V.K., Cell Biology, S.Chand and Company, 2016
155. Verma V., Plant Physiology, ANE books, 2009.
156. Verma, (1998). Text book of Economic Botany, Embay Publishers, New Delhi
157. Wadehra B. L., 2000. Law Relating to Patents, Trade Marks, Copyright Design and Geographical Indications, Universal Law Publishing
158. Wilson K., Walker J., Principles and techniques of Biochemistry and molecular Biology, 7th edition, Cambridge University Press, 2010.
159. Yadav, P. R., and Mishra, S. R. (2004) Environmental biology, Discovery publication, New Delhi.

T.Y.B.Sc. Applied Component Horticulture Syllabus
Credit Based and Grading System
To be implemented from the Academic year 2023-2024
Sem.-V and VI: Theory and Practical Content

Preamble: In the academic year 1979-80, an applied component was introduced for the T.Y. B.Sc. class in to enhance the skills essential for employability. Horticulture is a developing agricultural field that deals with the cultivation and processing of plants, fruits, vegetables, flowers, aromatic and medicinal plants. Horticulture includes the cultivation of fruits, vegetables, decorative flowers, fragrant and medicinal plants, as well as the post-harvest handling of those plants.

More people are becoming interested in the horticulture sector as a result of the government focusing on this sector due to its important contribution to the economy as a food producer, job creator, and supplier of commodities and services. About 20% of the agricultural GDP was made up of the horticulture sector, which also accounts for 4% of the national GDP.

Horticulture and gardening is a need-based and multidisciplinary subject. The syllabus must be updated to reflect current conditions. Similarly, an emphasis on entrepreneurial potential and skills should be incorporated into the curriculum by incorporating applied topics with commercial propositions. Similarly, because it is multidisciplinary, the syllabus must include a flexi concept.

The syllabus for the T.Y.B.Sc. Applied component is aimed to provide advanced knowledge and skills that are career-oriented. Fruit and vegetable production has surpassed food grain production in our country. It is a source of pride to acknowledge that India is the world's second largest producer of fruits and vegetables, ranking first in the production of banana, mango, lime and lemon, papaya, and okra.

As a result of the Faculty of Science's decision, the syllabus of the Applied Component is used in BOS Botany, where the flexi concept is introduced. The BOS experimented with the flexibility of selecting any four of the eight units included in the syllabus during the previous revision. The experiment was a success and was well received. It is also continued in this revised syllabus.

Thus, the BOS's revolutionary initiative in Botany, with inherent flexibility, aimed at providing need-based training catering to the needs of rural as well as urban niches, has been continued with this revision of syllabi as well. However, this flexibility is currently available. Only Applied Component subjects are eligible.

This curriculum covers both the fundamentals and advanced levels of plant propagation, gardening techniques, landscaping, commercial production, and preservation technology. Given the climate, Floriculture and Greenhouse production are given due importance. Improvement necessitates reducing natural crop destruction.

Horticulture's scope and business are expanding on a daily basis. Floriculture is a subcategory of horticulture and is the cultivation of flowering plants for use as a raw material in the pharmaceutical industry to make perfumes and cosmetics. Growing vegetables is an important factor of horticulture, which is in high demand in India.

Students can impart knowledge of practical business knowledge in the horticultural industry after the completion of this course.

Dr. V.M.Jamdhade
BOS Chairmen
& Professor & Head of Botany

(Any Four Module to be opted, Module I, II and III are compulsory, 4th Module to be opted out of Module IV and V)

Course Code	Unit	Title of the Unit and Paper	Credit	L/ Week
BNBUSBO5T5		**HORTICULTURE & GARDENING – I**	**04**	**08**
	I	Introduction to Horticulture	02	01
	II	Propagation of Horticultural plants		01
	III	Manures, Fertilizers and Garden implements		01
	IV	Garden Operation for Horticulture		01
	V	New Venture Creation & Entrepreneurship in Horticulture		
BNBUSBO5P3		**Practicals based on BNBUSBO5T5**	**02**	**04**
BNBUSBO6T5		**HORTICULTURE & GARDENING - II**		
	I	Landscape gardening	02	01
	II	High –tech Horticultural production		01
	III	Commercial Production		01
	IV	Post-harvest technology & entrepreneurship in horticulture		01
	V	New Venture Creation		01
BNBUSBO6P6		**Practicals based on BNBUSBO6T5**	**02**	**04**

T.Y.B.Sc. Sem-V Syllabus to be implemented from 2023-2024

Course Objectives

1. To understand the importance and objectives of different organisations, agencies, NGO's and business opportunities in horticulture.
2. To develop the sense of entrepreneurship and new venture creation in horticulture.
3. To apply advance plant propagation techniques and their management.
4. To study the future scope of organic farming and different garden operations for crop improvement.

5. To build knowledge about manures, fertilizers and garden implements.

Course Outcomes

The student would be able to……

1. Understand the scope and importance of different NGO's and Organisations related to horticulture.
2. Build the skills of entrepreneurship and would be able to create new ventures.
3. Execute the different propagation techniques of horticultural plants.
4. Know the application of different garden operations for crop improvement.
5. Develop different processing techniques and use them in marketing.

Course Code: BNBUSBO5T5 Course Title :Horticulture and Gardening – I	**Credits:2**	**No. of lectures:60**

Module	**Title of the Unit:**	**L/Week**	
Module-1	**Introduction to Horticulture**	15	
1.1	Definition, importance and objectives of Horticulture, branches of Horticulture, Pomology, Olericulture, Landscape Gardening, Nurseries and development		
1.2	Allied branches – Apiculture – Bee box, honey bee life cycle and role of apiculture in pollination, Sericulture – Silkworm life cycle, different types with host plant, Social Forestry, Exhibition: aims and objectives.		
1.3	Exhibition: aims and objectives Important Horticulture Research Institutes and Government Schemes for strategy plantations. Konkan Krishi Vidyapeeth – Dapoli, National Research Centre for grapes. Regional Fruit Research Centre Pune, Horticulture Training Centre (H.T.C.) – Talegaon. Central Potato Tuber Research Institute (CPTRI) – Shimla, Horticulture Consultancy		
Module-2	**Propagation of Horticultural plants**	15	
2.1	Definition, scope, and importance of plant propagation.		
2.2	**By Seeds** Advantages and disadvantages, method of seed propagation Production of seeds, Handling, Collection and Storage Sowing, Transplanting of seedlings and Hardening Seed treatment to control diseases Seedling diseases and their control. **By specialized Vegetative structures**: Bulbs, Tubers, Corms, Rhizomes, Root stock, runners, Offsets and suckers .		
2.3	**Layering** – Definition, Types: Simple, compound, (Serpentine) Tip, Trench, Mound, Air Layering. **Grafting-**Definition, advantages and disadvantages. Types: Splice, Whip/ Tongue, side, veneer, cleft, bark, epicotyls, approach, repair grafting – enarching, bridge and bracing. Stock- Scion relationships and Incompatibility. **Budding** – Definition, advantages and disadvantages. Types: T- budding, shield, patch , ring budding		
Module-3	**Manures, Fertilizers and Garden implements**	15	
3.1	**Manures**: Definition, importance, important manures. FYM (compost), Oil cakes, Green manure, Organic manures, and Vermicomposting. **Fertilizers:** Definition, types – straight, compound and mixed. Nitrogenous (NH4)2SO4, Urea, Ca (NO3)2, NH4Cl, Phosphatic (Superphosphate, Bone meal), Potassic (Muriate of potash, K2SO4). **Bio-fertilizers:** Definition types Bacteria, Cyanobacteria, Mycorrhiza, Sea weeds.		

3.2	**Friends of farmers**: Cattle, Lady Bug, Millipedes, Hummingbirds, Butterflies, Moths, Bats, Owls.		
3.3	**Garden implements** - Mower, Budding- cum- grafting knife, Pruning or slashing knife, Secateurs, Grass shear, Spade, Garden hoe, Khurpi, Sprayer, Watering can, Hand cultivator, Tree pruner, Flower scissors or cutters.		
Module-4	**Garden Operation for Horticulture**	15	
4.1	**Selection of site.** Preparation of soils for garden, Mulching, top- dressing, blanching Sowing, transplanting, tree transplanting. **Irrigation** - Overhead, Surface, Underground. **Weeding and pruning**, - Principles, Objectives and general technique.		
4.2	Bahar Treatment: Definition, principles and importance, types of bahar: Ambe bahar, Mrig bahar, Hasta bahar. Meth.		
4.3	Organic Farming. Definition, scope, Indian scenario, future scope. Maharashtra Organic Farming Federation, Pune		
Module-5	**New Venture Creation & Entrepreneurship in Horticulture**	15	
5.1	Production of Biofertilizer, Vermicomposting, establishment of medicinal herbal, and zodiac gardens, Terrace and Kitchen garden, *Spirulina,* and *Azolla* cultivation, Mushroom cultivation.		
5.2	Establishment of Soil Testing Laboratory. Commercial Production and Marketing of Oyster, Button Mushroom and fruits		
5.3	**Processing techniques:** Processing, storage, and marketing of Cocoa, Coconut (Copra, Coir, and Tender coconut), Rice (par boiled, raw rice, and rice flour), Pepper, Cardamom, Ginger, Arrowroot, Tapioca, Cashew, Mango, Jack fruit, Guava, Grapes, Lemon, Papaya, Musa, Garcinia.		
	Contemporary Issues	2	
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters.		
	Suggested activity: Seminar, quiz, debate, and visit to local flower show, agro clinics, Doodh dairy, vegetable market report on it.	2	

BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN
K1 - Remembering; K2 - Understanding; K3 - Applying; K4 - Analyzing; K5 - Evaluating

Course Code BNBUSBO5P3 **Course Title: HORTICULTURE AND GARDENING - I**	**Credits:1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	**P/Week**
1.	Calculation of fertilizer doses for various vegetable crops as per recommendation for N, P and K	1

2.	Calculation of quantity of seed required for sowing French bean, okra and turnip in 1000 m^2 area	1
3.	Common leaves used in flower arrangement - C*yprus, Asparagus, Palms, Cycad*s, and Ferns,Ive,Coleus,Acalypha	1
4.	Friends of farmers**:** Cattle, Lady Bug, Millipedes, Hummingbirds, Butterflies, Moths, Bats, Owls.	1
5.	Identification of common weeds in vegetable gardens.	1
6.	Identification of different chemical fertilizers	1
7.	Identification of organic manures-farm yard manure, Vermicomposting, cakes, bonemeal	1
8.	Identification of seeds of different vegetable crops	1
9.	Preparation of media for growing different ornamental plants	1
10.	Preparation of potting mixtures, and polybags.	1
11.	Preparation of the following Natural insecticides- Neem Arka , Dashparni Arka, Seetaphal Powder , Tobacco Extract.	1
12.	Propagation of horticultural crops through cuttings	1
13.	Propagation of horticultural plants through budding	1
14.	Propagation of horticultural Plants through grafting	1
15.	Propagation of horticultural plants through layering, runners and suckers	1
16.	Propagation of horticultural Plants/ornamental flower through seeds	1
17.	Study about Garden Tools and Implements	1
18.	Study of Pots, Potting, Depotting and Repotting	1
19.	To study dry flower making; Dry flower buckets, Bouquets, Wall hangings, Greeting cards.	1
20.	Visiting local market to identify different vegetable crops on the basis of plant part consumed	1

Course Code	Course Title	Credits	No. of lectures
BNBUSBO6T5	**Horticulture and Gardening - II**	**2.5**	**60**

Course Objectives

1. To learn the basic principles of landscape gardening, various garden features, types of gardens, and agribusiness.
2. To develop the skill about post-harvest technology and entrepreneurship in horticulture.
3. To learn the commercial production of horticulture produce.
4. To understand the scope the High–tech horticultural production in floriculture and post-harvest management.
5. To understand the role of different factors in post-harvest technology.

Course Outcomes

The student would be able to

1. Understand the garden features of specialized gardens and garden design.

2. Apply the knowledge of post-harvest technology in horticulture.
3. Summarize the commercial produce of horticultural produce.
4. Develop the skill of High-tech and value added production from Horticultural and Floriculture crops.
5. Recognise the role of different factors in post -harvest Technology.

Module	**Title of the Unit:**	**L/Week**
Module-1	**Landscape gardening**	15
1.1	Definition, objectives, and scope - different types of Gardening and design. Landscape Features: Edges, Hedges, and Arches, Pergolas, Avenues, Flower beds, Trellis and Topiary.	
1.2	**Garden feature**: Garden pool, waterfall, fountain, rocks, walk, pavements, bridges, lawns, fences, gates, statues, towers, plant raised beds and containers.	
1.3	**Specialized Gardens**: Aquatic garden, Rock garden, Kitchen garden, Herbal Garden, , Mughal garden, Buddhist garden, Terrace garden and Nakshtra garden.	
Module-2	**High –tech Horticultural production**	15
2.1	**High –tech Horticultural production**- Green house technology- Meaning, types, layout & construction, irrigation systems. Care & attention. Hardening of plants.	
2.2	**Floriculture–** Scope and importance, soil and climatic requirement and cultivation practices and Economics of greenhouse production of Gerbera and Orchids.	
2.3	Floral decoration, Florist shop management. Role of NABARD in supporting Hi-tech Agriculture.	
Module-3	**Commercial Production**	15
3.1	Definition objective and scope of commercial production in relation to propagation, post-plantation care, harvesting, post-harvest management, and varieties.	
3.2	Cultivation of Varieties of the following: **Tuber**-Potato, Vegetable**-** Tomato, **Fruits-Mango, Grapes**. **Spices/condiments-Chilies**, **Medicinal plants-** Aloe vera .	
3.3	Functions of APMC, mega food park is an industrial park meant for the food processing industry. Opportunities and scope in food processing industry in India.	
Module-4	**Post-harvest technology & entrepreneurship in horticulture**	15
4.1	Post-Harvest Management: post-harvest management of fruits, flowers & vegetables (washing & drying, sorting & grading, waxing, ripening, pre-packaging, transportation & storage).	
4.2	Maturity: Factors responsible for maturity & ripening methods used for delaying ripening.	
4.3	Marketing- grading, packing & transportation. Ways of increasing the market value and shelf life of horticultural produce. Horticultural business, management and Entrepreneurship development Horticulture as a business definition and nature, organization, planning and operation of Horticulture farm business.	
Module-5	**New Venture Creation**	15
5.1	Establishment, Management and Marketing in Commercial Nursery. Licensing, Marketing and Export of Agri-Products	
5.2	Establishment and marketing of Dairy Products.	
5.3	Establishment and marketing of Jackfruit and Banana, Establishment of Agro tourism.	
	Contemporary Issues	2
	Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters.	
	Suggested activity: Seminar, quiz, debate, and visit to local flower show, agro clinics, Doodh dairy, vegetable market report on it.	2

Course Code: **BNBUSBO6P6** Course Title :**HORTICULTURE AND GARDENING - II**	**Credits** **1.5**	**No. of Practical / Week - 01 (4 Periods)**

	Name of the experiment	P/Week
1.	Identification of the following important horticultural plants: **Herbs** – foliage any 2 and flowering any 2 , **Shrubs** – foliage any 2 flowering any 2 , **Trees** – foliage any 2 and flowering any 2 ; **Climbers** – any 2 ; **Lianas** – any 2 ; **Epiphytes** – any 2 ;**Creepers** –any 2 ; **Trailers** – any 2 ; **Aquatic plants** – any 2 (preferably various habitat) ; **Succulents** – any 2 ; **Weeds** – any 5.	02
2.	Identification of varieties of Tomato, Chilli, Mango, Grapes & Coconut.	01
3.	Method of preparing Terrarium/Bottle garden/dish garden	01
4.	Flower arrangements –Indian (Gajara, Veni, Garland)	02

5.	Flower arrangements floating rangoli/Bio-Rangoli), Japanese and western type (demonstration)	01
6.	Preparation of squashes/ jam/Gulkand/Gulabjal/Papaya Cherry	01
7.	Preparation of pickles, and sauces.	01
8.	Fruit and vegetable carving (Demo)	02
9.	Preparation of instant beverage using wild fruit (Karwand/ Kokum/ Jamun/ Mango)	01
10	Preparation of compost using different lab and kitchen waste.	01
11	Estimation of germination percentage of seeds.	01
12	To study how to prepare conservatory and lathe houses and to study plants used for conservatory and lathe houses.	01
13	To study the layout and planting of the orchard	01
14.	**Greenhouse plants**- Information regarding to soil, temperature, irrigation, fertilizer requirements, and propagation methods for *Anthurium, Gerbera*, Orchids, Carnation, Roses, Capsicum, Tomato, and Strawberry.	01

After successful complete of this course students will Job opportunity/ Entrepreneurship:
India is mostly an agricultural nation, which expands its use and utility. Technology is developing rapidly. There are several career and professional prospects with this degree. The following fields offer career prospects in both the public and commercial sectors:
Plantation Manager, Seed Technologies Firm, Operations Manager in Fertilizer Units, Agribusiness Development Manager, Food Processing Units in Government, Subject Matter Specialist in different Krishi Vigyan Kendras (KVKs),Crop production - fruit, vegetables, nursery stock, Landscape design, Landscape construction and management, Parks management, Sports turf construction and management including football pitches, bowling greens, racecourses, golf courses, Horticultural education and training, Retails sales outlets - garden centers, florists, horticultural materials suppliers. Garden supervisor in Municipal Corporation, Garden, Curator, Horticulture officer, Section officer, Landscaping officer, Food Safety Officer, Agriculture Field Officer, Horticulture Manager, Farm Manager, Nursery operator, and other positions are available.

Evaluation Scheme: Internal Assessment: The internal assessment of 40 Marks for each course will be as follows: Continuous Internal Assessment (I. A.) will be conducted by Department of Botany Independently (30 M for curriculum and Extra-curriculum & 10 M for Active Participation & Leadership qualities).

Curriculum and Extra-curriculum	**Active Participation & Leadership qualities**	**Total**
30	**10**	**40**

Internal Assessment may include:

Curriculum and Extra-curriculum (30M)
• **Research** – Presentation/ Paper review/ Book review/ Project/ Publication of Research Paper (10 M each activity) **OR** • **Writing skills -** Essay writing/ Report on - Campus visit/ Industry Visit/ Field Trip/ Visit to a garden/ Report on Conference – Workshop – Seminar – Webinar attended/ Intercollegiate competition participation/ Science movies review/ Assignment/ Case studies on topics assigned (10 M each activity)

OR

- **Skill development** – Flip the class/ Debate/Group Discussion/ Quiz/ e-herbarium/ Photo gallery- Nature Photography, Flora & Fauna/ Botanical illustrations/ Model making/ Survey of topic assigned (10 M each activity)

OR

- **Green Campus efforts -** Raising and maintaining plant/ maintenance of departmental garden (10 M/each activity)

OR

- **Active participation in Departmental Club (Botany Club/ Movie & Journal Club)** (10 Mb each activity)

OR

- **Class test -30 (Short notes)**

OR

- **Certification from Swayam / NPTEL (Courses in Biosciences) (10 M each course)**

OR

- **Certificate course run by the department (30 M)**

OR

- **Actively participated in Botany Department Seed Ball Preparation events (10 M)**

Marks Distribution and Passing Criterion for Each Semester

Theory				**Practical**			
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
Course Code	40	16	60	24		100	40
Course Code	40	16	60	24		100	40

Sem-V and Sem-VI Theory Paper Pattern:

Sem-V: BNBUSBO5T5 : Horticulture and Gardening – I

Sem-VI: BNBUSBO6T5: Horticulture and Gardening – II

Course code		**Duration**	**2.00 Hrs.**	**Max.Marks :60**
				Marks
Q.1.	Answer any two of the following (Based on Unit-I)			12
a.				
b.				
c.				
d.				
Q.2.	Answer any two of the following (Based on Unit-II)			12

a.		
b.		
c.		
d.		
Q.3.	Answer any two of the following (Based on Unit-III)	12
a.		
b.		
c.		
d.		
Q.4.	Answer any two of the following (Based on Unit-IV)	12
a.		
b.		
c.		
d.		
Q.5.	Answer any two of the following (Based on Unit-V)	12
a.		
b.		
c.		
d.		
Q.6.	Answer in brief any four of the following (Based on Unit-I, II and III out of six)	12
a.		
b.		
c.		
d.		
e.		
f.		

ENTREPRENURSHIP PROJECTS BASED ON SEM V AND SEM VI HORTICULTURE TOPICS FOR ASSIGNMENTS TO BE GIVEN TO THE STUDENTS Feasibility report of setting up a small/medium scale unit relevant to the topic	
1. Classification, the technology of Beekeeping	2. Technology of Horticulture practices of mango plantation.

3. Fruit Processing Unit	4. Manufacturing of Bio-fertilizers and PGR
5. Classification & technology of Sericulture.	6. Spirulina production
7. Technology and practices of management of household pest control.	8. Packing bag manufacturing unit
9. Nutritional parameters & technology of preparation of Chocolate	10. Manufacturing of Jaggery
11. Nutritional parameters & technology of preparation of Ice-cream	12. Dairy & Milk collection center
13. Technology of preparation of Pulps, squash, and jam.	14. Soil & water testing Laboratory
15. Nutritional parameters &; technology of preparation of Ketchup and sauce.	16. Manufacturing of cattle feed
17. Technology of Cashew processing and its marketing.	18. Manufacturing of farm machineries
19. Technology of manufacturing of wafers and its marketing.	20. Nursery & Landscaping
21. Technology of extraction of colors/ essence/ flavours from natural resources.	22. Black pepper processing unit
23. Technology of preparation and preservation of Upma (Ready to cook)	24. Shed net vegetable cultivation and sale
25. Technology of preparation and preservation of vegetables (Ready to eat)	26. Manufacturing of Bio-fuel
27. Technology of manufacturing herbal beauty products (Gel, Lotion formulation, Shampoos, Creams, etc.)	28. Cow dung-based mosquito repellent
29. Technology of manufacturing Wine.	30. Cashew Processing Unit
31. Technology of propagating cut-flowers in playhouse.	32. Mushroom farming
33. Technology of propagating Orchid in playhouse.	34. Technology of Mocktails/ Cocktails
35. Technology of setting up a nursery and sale of plants and accessories.	36. Tissue Culture Banana sapling production and sale
37. Technology of Horticulture practices of Cashew plantation.	38. Technology of Horticulture practices of Coconut plantation.
39. Protected Vegetables Cultivation	40. Bee Keeping and Consultancy
41. Banana Export	42. Vermicomposting
43. Essential Oils	44. Agro-tourism
45. Vegetable cultivation & marketing	46. Manufacturing Coconuts Chips
47. Spices Processing Unit	48. Bamboo cultivation
49. Goat farming	50. Pulses Processing Unit

51. Soil & Water Testing Laboratory	52. Raisin processing Unit
53. Floriculture (Lily)	54. Animal feed processing unit
55. Neem Seed Cake	56. Manufacturer Neem & Karana Oil
57. Online sale of organic products	58. Establishment of Food Mall
59. Establishment of Nursery and to sale plants	60. Establishment of Pet care clinic

SEM-V PRACTICAL PATTERN

V.P.M.'S B. N. Bandodkar College of Science, (Autonomous) Thane

(Affiliation to University of Mumbai)

Applied Component- Horticulture and Gardening - I

	Title: Horticulture and Gardening – I (Course code: BNBUSBO5P3	**Duration:04 Hrs.**	**Max.Marks: 100**
Q.	**Name of the Experiment**		**Marks**
1.	Propagation of horticultural crops through cuttings/Propagation of horticultural plants through budding/Propagation of horticultural Plants through grafting/Propagation of horticultural plants through layering, runners and suckers/Propagation of horticultural Plants/ornamental flower through seeds.		**07**
2.	Calculation of fertilizer doses for various vegetable crops as per recommendation for N, P and K/ Calculation of quantity of seed required for sowing French bean, okra and turnip in 1000 m2 area		**10**
3.	Preparation of media for growing different ornamental plants/ Preparation of the following Natural insecticides- Neem Arka , Dashparni Arka, Seetaphal Powder , Tobacco Extract.		**07**
4.	The given sample to exhibit the dry flower making/; Dry flower buckets/, Bouquets/, Wall hangings/, Greeting cards		**10**
5.	Identification of different chemical fertilizers/ Identification of organic manures-farm yard manure, Vermicomposting, cakes, bonemeal		**08**
	Identification of common weeds in vegetable gardens. Identification of seeds of different vegetable crops. Identification of garden tools and implements/ identification of different irrigation systems. Identification of friend of farmers. Identification of common leaves used in flower arrangements.		**18**
6.	**Journal**		**05**
	Field/ Industrial visit		**10**
	Viva voce		**05**
	Project		**20**
	Key-		

SEM-VI PRACTICAL PATTERN

V.P.M.'S B. N. Bandodkar College of Science, (Autonomous) Thane

(Affiliation to University of Mumbai)

Applied Component- Horticulture and Gardening - I

Course code:	**Title: Horticulture and Gardening - II**	**Duration:04 Hrs.**	**Max.Marks:100**

BNBUSBO6P6			
Q.	**Name of the Experiment**		**Marks**
1	Prepare an appropriate garden plan for the given area A, which will include the locations _____, _____ and _____. Suggest at least two names of plants for each location.		**08**
2	Use the given material **B** to make a Terrarium / Dish Garden/bottle garden/hanging basket		**10**
2	Use the given material **C** to create Garland/ Bio jewellery / Fruit and vegetable carving.		**10**
2	Prepare pickle from the given material **D** using appropriate proportions/ Preparation of Sharbat using Karwand, Kokum, and Jamun.		**10**
2	Estimation of germination percentage of seeds **E**/ Preparation of compost/Vermi-composting using different substrates.		**10**
3	Identify the horticultural plants **F, G** and comment on their importance.		**06**
3	Identify the commercial varieties **H** and comment on their significance.		**03**
3	Identify the greenhouse plant **I** comment on its propagation and requirements.		**03**
4	Journal		**05**
4	Field/ Industrial Visit		**10**
4	Viva voce		**05**
5	Project		**20**
	Key- A; Private / Public garden plan, B: Dish garden / Terrarium, C: Bonsai / Hanging basket, D: Flowers and other required materials for any type of flower arrangement mentioned. E: Fruits and vegetables and other requirements for bio jewellery and carving. F, G, H: Horticultural plants I, J: Commercial varieties': Greenhouse plant		

References

1. Acquaah, G. 2011.Horticulture: Principles and Practices. (4th ed), Pearson Education, London, UK.
61. Agrawal, P. K., 1993, Hand Book of Seed Technology, Dept. of Agriculture and Corporation, National Seed Corporation Ltd., New Delhi.
62. Aldriance, G.W. and Brison, F.R. (2000). Propagation of horticultural plants. Mc Grow Hill Book Company. Inc, New York.
63. Arora J. S. (1998). Introductory Ornamental Horticulture. Kalyani Publishers Pvt. Ltd. Bengal.
64. Ashman, M.A. and Puri, G. 2002. Essential soil science-A clear and concise introduction to soil science. Blackwell scientific publishers, London.
65. Azad, K. C. and Sharma, V. K. (2000). Horticulture Technology (Vol. I&II). Deep and Deep Publications, New Delhi, India.
66. Bal, J.S. (2007). Fruit growing. Kalyani Publishers, Ludhiana, India.
67. Bhattacharjee S. K., and De L. C. (2005). Post-harvest technology of flowers and ornamental plants. Pointer Publishers, Jaipur.
68. Book, L. and Phillips, D. P. 2013. Creativity and entrepreneurship: Changing currents in education and public life. Edward Elgar Publishing, Cheltenham, UK.
69. Bose, T. (1996). Fruit tropical and Sub tropical. Naya Prakashan , Calcutta, India.
70. Bose, T.K., Mitra, S.K. and Rathore, D.S (1991). Temperate fruits. Naya Prakashan Publishers, Kolkata, India.
71. Bose, T.K., Mitra, S.K., Sadhu, M.K. and Das, P. (1997). Propagation of tropical and sub-tropical horticultural crops. 2nd Edition, Naya Prakashan, Kolkata.
72. Chadha, K.L. (2001). Text book of Horticulture. ICAR, New Delhi.
73. Chadha, T.R. (2000). Textbook of temperate fruits. ICAR, New Delhi
74. Chandha K L, 2003. *Handbook of Horticulture.* ICAR. New Delhi
75. Chattopadhyay, T.K. (2008). A textbook on Pomology, Vol. 4 (Temperate fruits), Kalyani publishers, Ludhiana, India.
76. Chaudhary, M.L. and Prasad, K.V. (2003). Value addition in Horticulture. DAHS, Division of Floriculture and Landscaping, IARI, New Delhi-12
77. Das P.C.,Manures and Fertilizers,Kalyani Publication, 2003
78. De L. C. (2011). Value addition in flowers and Orchids. New India Publishing Agency, New Delhi.
79. Dubey, R. C., 2005, A Text Book of Biotechnology, S. Chand & Co., New Delhi.
80. George, Acquaah (2008). Horticulture: Principles and Practices, 4th Ed. PHI Learning private Ltd. New Delhi, India.
81. Girdhari Lal., Siddhappa, G. S. and Tandon, G. L. (1998). Preservation of fruits and vegetables. ICAR New Delhi, India.
82. Hartman, H.T, Kester, D.E. and Davies, F.T. (1993). Plant propagation: Principles and Practices. 5th Edition. Prentice Hall of India, New Delhi.
83. Janick Jules, 1979, Horticultural Science, (3rd Ed.), W. H. Freeman and Co., San Francisco, USA.
84. Khan, M. R. (1995). Horticulture and Gardening. Nirali Prakashan, Pune, India.
85. Kumar N, 1994. *Introduction to Horticulture*. Rajalakshmi Pub. Nagarcoil.
86. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
87. Kumaresan, V., 2005, Biotechnology, Saras Publications, New Delhi.
88. Kunte, Kawthalkar, Yawalker, 1997. Principles of Horticulture and Fruit Growing. Agri–Horticulture Co.
89. Manibhushan Rao K, 2005. *Text Book of Horticulture* (II Edn.). Macmillan India Ltd.
90. Meyer, M. H. and Crane, F. G. 2013. New Venture Creation: An Innovator's Guide to Entrepreneurship, 2nd ed., Sage Publications, California.
91. Prem Singh Arya, 2004. *Vegetable Seed Production Principles*. Kalyani Publishers.
92. Randhawa G S and Mukhopadhyay A, 1986. *Floriculture in India*. Allied Publishers Pvt. Ltd. Ahmedabad.
93. Reddy, Mallikarjun and Rao, Aparna (2010). Applied Horticulture. Pacific Book International, Delhi, India.
94. Sadhu M K, 1989. *Plant propagation*. New Age International Publishers, New Delhi.
95. Sandhu, M. K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
96. Sathe, T. V. 2004, Vermiculture and Organic Farming, Daya Publishers.
97. Schilletter J C and Richey H W, 2005. *Text Book of General Horticulture*. Biotech Books, New Delhi.
98. Sharaf, Sandhya (2012). Green House Management of Horticulture Crops. Oxford book Co. New Delhi, India.
99. Sharma R R, 2005. *Propagation of Horticultural Crops*. Kalyani Publishers.
100. Sharma, K.K. and Singh, N.P. (2011). Soil and orchard management. Daya Publishing House, New Delhi.
101. Sharma, R.R. & Krishna, H. (2013). Textbook on plant propagation & nursery management. Intl. Book Distributing Co., Lucknow, India.
102. Sharma, R.R. (2002). Propagation of horticultural crops: Principles and Practices. Kalyani Publishers, New Delhi.

103. Sharma, R.R. (2006). Fruit production: Problems and solutions. Intl. Book Distributing Co., Lucknow, India.
104. Sharma, R.R. 2016. Propagation of horticultural crops. Kalyani Publishers, New Delhi.
105. Sharma, S.K. (2010). Post-harvest management and processing of fruits and vegetables. NIPA, New Delhi.
106. Sharma, V. K. (2004). Advances in Horticulture. Deep and Deep Publications, New Delhi, India.
107. Sharon Pastor Simson, Martha C. Straus (2010). Basics of Horticulture. Oxford Book Co. New Delhi, India.
108. Siddappa, G. and Tandon, D.K. (1998). Preservation of fruits and vegetables. ICAR, New Delhi
109. Singh, A. (2000). Fruit physiology and production. Kalyani Publishers, Ludhiana, India.
110. Singh, S.P. (2000). Commercial fruits. Kalyani Publishers, Ludhiana, India.
111. Singh, V. B. (1990). Fruits of NE Region. Wiley Eastern Limited, New Delhi, India.
112. Sonane, H. N., Deore, B. P. and Patil, S. K. (1984). Vaishali (RHR 51) A High yielding Variety of Brinjal for Maharashtra. Journal of Maharashtra Agriculture Uni. 9(3):341-342
113. Srivastava, R.P. and Kumar, S. (2001). Fruit and vegetable preservation: Principles and practices. International Book Distributing Co., Lucknow, India.
114. Subba Rao, N.S. 1997. Biofertilizers in Agriculture and Forestry. India Book House Limited, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi
115. Subha Rao, N. S., 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
116. Veerabhadrappa H. 2009. Management and entrepreneurship. New Age International, New Delhi.
117. Verma, L.R., Joshi V. K. Post-Harvest Technology of fruits and Vegetables, Handling, processing, fermentation, and waste management Vol II,Indus Publishing company,2000
118. Vishnu Swarup (1997). Ornamental horticulture. Macmillan Ltd. New Delhi, India.
119. Vyas, S. C, Vyas, S. and Modi, H. A., 1998, Bio-fertilizers and Organic Farming, Akta Prakashan, Nadiad.
120. Randhawa G. S., and Mukhopadhyay A., (2007). Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
121. De L. C., (2011). Value addition in flowers and Orchids. New India Publishing Agency, New Delhi.