



Hindi Vidya Prachar Samiti's
Ramniranjan Jhunjhunwala College
of Arts, Science & Commerce
(Autonomous College)

Affiliated to
UNIVERSITY OF MUMBAI

Syllabus for the T.Y.B.Sc.

Program: B.Sc. BOTANY

Program Code: RJSUBOT

(CBCS 2019-2020)

T.Y.B.Sc Botany Syllabus Semester V & VI**DISTRIBUTION OF TOPICS AND CREDITS****T.Y.B.Sc. BOTANY SEMESTER V**

Course	Nomenclature	Credits	Topics
RJSUBOT501	Plant Diversity III	2.5	1. Microbiology 2. Algae 3. Fungi 4. Plant Pathology
RJSUBOT502	Plant Diversity IV	2.5	5. Palaeobotany 6. Angiosperms I 7. Anatomy I 8. Palynology
RJSUBOT503	Form and Function III	2.5	9. Cytology and Molecular Biology. 10. Physiology 11. Environmental Botany 12. Plant Tissue Culture
RJSUBOT504	Current Trends in Plant Sciences II	2.5	13. Ethnobotany and Mushroom Industry 14. Biotechnology I 15. Instrumentation 16. Pharmacognosy and Medicinal botany
RJSUBOT501, RJSUBOT502, RJSUBOT503 & RJSUBOT504	Practical I, II, III & IV	06	

T.Y.B.Sc. BOTANY SEMESTER VI

Course	Nomenclature	Credits	Topics
RJSUBOT601	Plant Diversity III	2.5	1. Bryophyta 2. Pteridophyta 3. Bryophytes and Pteridophytes: Applied Aspects. 4. Gymnosperms
RJSUBOT602	Plant Diversity IV	2.5	5. Angiosperms II 6. Anatomy II 7. Embryology 8. Biostatistics
RJSUBOT603	Form and Function III	2.5	9. Plant Biochemistry 10. Plant Physiology II 11. Genetics 12. Bioinformatics
RJSUBOT604	Current Trends in Plant Sciences II	2.5	13. Plant Biotechnology II 14. Plant Geography 15. Economic Botany 16. Post-Harvest Technology
RJSUBOT601, RJSUBOT602, RJSUBOT603 & RJSUBOT604	Practical I, II, III & IV	06	

SEMESTER V (THEORY)		L	Cr
Paper-I: PLANT DIVERSITY- III		Paper Code: RJSUBOT501	
		60	2.5
UNIT I		15	
Microbiology			
1	Types of Microbes.		
2	Culturing: Sterilization, media- types and composition, staining, colony characters.		
3	Pure cultures.		
4	Role of microbes in fermentation: Alcohol and Antibiotics- Penicillin		
UNIT II		15	
Algae			
1	Division <u>Rhodophyta</u> : Outline Classification up to order as per G. M. Smith. General Characters based on: Distribution, Cell structure, pigments, reserve food, range of thallus, reproduction: asexual and sexual. Economic Importance of Rhodophytes.		
2	<u>Polysiphonia</u> – Systematic position, Life cycle and Alternation of generations.		
3	Division <u>Chrysophyta</u> : Outline Classification up to class as per G. M. Smith. General Characters of Xanthophyceae based on: Distribution, Cell structure, pigments, reserve food, range of thallus, reproduction: asexual and sexual. Economic Importance of Chrysophyta.		
4	<u>Vaucheria</u> : Systematic position, Life cycle and Alternation of generations.		
UNIT III		15	
Fungi			
1	Basidiomycetes: Outline Classification up to order as per G. M. Smith. General Characters based on : Thallus, Reproduction.		
2	<u>Agaricus</u> - Systematic position, Life cycle and Alternation of generations.		
3	<u>Puccinia</u> - Systematic position, Life cycle and Alternation of generations.		
4	Deuteromycetes: Outline Classification up to order as per G. M. Smith. General Characters.		
5	Life cycle of <u>Alternaria</u> .		

UNIT IV		15	
Plant Pathology			
1	Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures of the following: a) White Rust – <i>Albugo</i> sp. b) Tikka disease of ground nut: <i>Cercospora</i> sp. c) Citrus canker – <i>Xanthomonas</i> sp. d) Leaf curl – leaf curl virus. e) Plant disease caused by insect pest- Aphids		
2	Study of Physical, chemical and biological control methods of plant diseases.		
SEMESTER V (THEORY)		L	Cr
Paper-II: PLANT DIVERSITY- IV		Paper Code: RJSUBOT502	
		60	2.5
UNIT I		15	
Palaeobotany			
1	<i>Calamites</i> – All form genera Stem, leaf, male and female fructification.		
2	<i>Lepidodendron</i> –All form genera root, stem, bark, leaf, male and female fructification.		
3	<i>Lyginopteris</i> – All form genera root, stem, leaf, male and female fructification.		
4	<i>Pentoxylon</i> – All form genera.		
5	Contributions of Birbal Sahni, (Birbal Sahni Institute of Palaeobotany, Lucknow).		
UNIT II		15	
Angiosperms- I			
1	Morphology of fruits- Simple, Aggregate and Composite.		
2	Complete classification of Bentham and Hooker (only for prescribed families), Merits and demerits.		
3	Bentham and Hooker's system of classification for flowering plants up to family with respect to the following prescribed families and economic and medicinal importance for members of the families: a) Capparidaceae b) Umbelliferae c) Cucurbitaceae d) Rubiaceae e) Solanaceae f) Commelinaceae g) Graminae		

UNIT III		15	
Anatomy – I			
1	Anomalous secondary growth in the Stems of <i>Bignonia</i> , <i>Salvadora</i> , <i>Achyranthes</i> , <i>Aristolochia</i> , <i>Dracaena</i> . Storage roots of Beet, Radish.		
2	Root- stem transition.		
3	Types of Stomata – Anomocytic, Anisocytic, Diacytic, Paracytic, and Gramineaceous.		
UNIT IV		15	
Palynology			
1	Pollen Morphology.		
2	Pollen viability – storage.		
3	Germination and growth of pollen.		
4	Application of Palynology in honey industry, coal and oil exploration, Aerobiology and pollen allergies, forensic science.		
		L	Cr
Paper-III: FORMS AND FUNCTIONS – III		Paper Code: RJSUBOT503	
		60	2.5
UNIT I		15	
Cytology And Molecular Biology			
1	Structure and functions of nucleus.		
2	Structure and functions of vacuole.		
3	Structure and functions of giant chromosomes.		
4	The genetic code: Characteristics of the genetic code.		
5	Transcription and Translation in Prokaryotes and Eukaryotes.		
UNIT II		15	
Physiology			
1	Mineral Nutrition in plants		
2	Transpiration and stomatal movement		
3	Solute transport: Transport of ions across cell membranes, active and passive transport, carriers, channels and pumps.		
4	Translocation of solutes: Composition of phloem sap, girdling experiment, pressure flow model, phloem loading and unloading, anatomy of sieve tube elements, mechanisms of sieve tube translocation, Munch's hypothesis.		

UNIT III		15	
Environmental Botany			
1	Bioremediation: Principles, factors responsible and microbial population in bioremediation.		
2	Phytoremediation: Metals, Organic pollutants.		
3	Plant succession: Hydrosere and Xerosere –Succession in water, succession on barren land, ecesis citing different seres leading upto the climax, mono- and poly- climax theories.		
UNIT IV		15	
Plant Tissue Culture			
1	Aspects of micropropagation with reference to Floriculture: Detailed study of Orchid cultivation.		
2	Plant cell suspension cultures for the production of secondary metabolites, with special reference to Shikonin production.		
3	Somatic embryogenesis and artificial seeds: General account based on- a) Types and Technique. b) Advantages/Importance.		
4	Protoplast fusion and Somatic hybridization: a) Concept, definition, and various methods of protoplast fusion b) Applications of somatic hybridization in agriculture.		
		L	Cr
Paper-IV: CURRENT TRENDS IN PLANT SCIENCES- II		Paper Code: RJSUBOT504	
		60	2.5
UNIT I		15	
Ethnobotany And Mushroom Industry			
1	Ethnobotany - Definition, history, sources of data and methods of study.		
2	Traditional medicines as used by tribal in Maharashtra towards: a) Skin ailments: <i>Rubia cordifolia</i> , <i>Santalum album</i> . b) Liver ailments: <i>Phyllanthus</i> , <i>Andrographis</i> . c) Wound healing and ageing: <i>Centella</i> , <i>Typha</i> , <i>Terminalia</i> , <i>Tridax</i> . d) Fever: <i>Vitex negundo</i> , <i>Tinospora cordifolia</i> leaves e) Diabetes: <i>Momordica charantia</i> , <i>Syzygium cuminii</i> .		
3	Mushroom industry: i) General account of production of mushrooms with respect to methods of Composting, spawning, casing, harvesting of mushroom. Cultivation of <i>Pleurotus</i> and <i>Agaricus</i> mushroom to be studied in detail. ii) General account of mushrooms: Nutritional value, picking and packaging, economic importance. iii) Entrepreneurship in Mushroom Industry		

UNIT II		15	
Biotechnology – I			
1	Construction of genomic DNA libraries, Chromosome libraries and c- DNA libraries.		
2	Identification of specific cloned sequences in c-DNA libraries and Genomic libraries.		
3	Analysis of genes and gene transcripts – Restriction enzyme, analysis of cloned DNA sequences.		
4	Hybridization (Southern Hybridization).		
UNIT III		15	
Instrumentation			
1	Microscopy II- Instrumentation, working, principle and applications of SEM and TEM.		
2	Chromatography II: General account of Column chromatography. Principle and bedding material involved in adsorption and partition chromatography, Ion exchange chromatography, molecular sieve chromatography.		
UNIT IV		15	
Pharmacognosy And Medicinal Botany			
1	Monographs of drugs with reference to biological sources, geographical distribution, common varieties, macro and microscopic characters, chemical constituents, therapeutic uses, adulterants- <i>Strychnos</i> seeds, Clove buds, <i>Allium sativum</i> , <i>Acorus calamus</i> and <i>Curcuma longa</i> .		
SEMESTER VI		L	Cr
Paper I: PLANT DIVERSITY- III		Paper Code: RJSUBOT601	
		60	2.5
UNIT I		15	
Bryophyta			
1	<i>Marchantia</i> - Systematic position as per G. M. Smith, life cycle and Alternation of generations		
2	<i>Pellia</i> - Systematic position G. M. Smith, life cycle and Alternation of generations as per.		
UNIT II		15	
Pteridophyta			
1	<i>Lycopodium</i> - Systematic position (as per G. M. Smith), Life cycle, Alternation of generations.		
2	Calamophyta – Outline Classification upto orders as per G. M. Smith.		
3	General characters of Calamophyta		

4	<i>Equisetum</i> : Systematic position, Life cycle, Alternation of generations.		
UNIT III		15	
Bryophytes And Pteridophytes: Applied Aspects			
1	Ecology of Bryophytes.		
2	Economic importance of Bryophytes.		
3	Bryophytes as ecological indicators. Evolution of Sporophyte and Gametophyte in Bryophytes.		
4	Economic importance of Pteridophytes.		
5	Diversity and distribution of Indian Pteridophytes.		
UNIT IV		15	
Gymnosperms			
1	<i>Biota (Thuja)</i> - Systematic position as per Coulter and Chamberlain, Life cycle, Alternation of generations.		
2	<i>Gnetum</i> -Systematic position as per Coulter and Chamberlain, Life cycle, Alternation of generations.		
3	<i>Ephedra</i> -Systematic position as per Coulter and Chamberlain, Life cycle, Alternation of generations.		
		L	Cr
Paper II: PLANT DIVERSITY - IV		Paper Code: RJSUBOT602	
		60	2.5
UNIT I		15	
Angiosperms- II			
1	Major Botanical gardens of India – Indian Botanical Garden, Howrah; National Botanical Research Institute's Garden (NBRI), Lucknow; Lloyd Botanical Garden, Darjeeling; Lalbaugh or Mysore State Botanical Garden, Bangalore.		
2	Botanical Survey of India and regional plants of India.		
3	Study of following plant families along with economic and medicinal importance : a) Rhamnaceae b) Combretaceae c) Asclepiadaceae d) Labiatae e) Euphorbiaceae f) Cannaceae		
4	Hutchinson's classification – merits and demerits.		

UNIT II		15	
Anatomy – II			
1	Ecological anatomy: a) Hydrophytes – submerged, floating rooted. b) Hygrophytes - <i>Typha</i> c) Mesophytes. d) Sciophytes. e) Halophytes. f) Epiphytes. g) Xerophytes.		
UNIT III		15	
Embryology			
1	Microsporogenesis		
2	Megasporogenesis - Development of monosporic type, examples of all embryo sacs.		
3	Types of ovules.		
4	Double fertilization.		
5	Development of embryo – <i>Capsella</i> .		
UNIT IV		15	
Biostatistics II			
1	Testing of hypothesis- student's <i>t</i> -test (paired and unpaired). Theory and Problems based on these.		
2	Regression- Theory and Graphical method only.		
3	ANOVA (one way).		

		L	Cr
PAPER III: FORM AND FUNCTION - III		Paper Code: RJSUBOT603	
		60	2.5
UNIT I		15	
Plant Biochemistry			
1	Structure of biomolecules: Carbohydrates (sugars, starch, cellulose, pectin), lipids (fatty acids and glycerol), proteins (amino acids).		
2	Enzymes: Nomenclature, classification, mode of action, Enzyme kinetics, Michaelis- Menten equation, competitive, non-competitive, and uncompetitive inhibitors.		
UNIT II		15	
Plant Physiology- II			
1	Nitrogen metabolism: Nitrogen cycle, root nodule formation, and leg haemoglobin, nitrogenase activity, assimilation of nitrates, (NR, NiR activity), assimilation of ammonia, (amination and transamination reactions), nitrogen assimilation and carbohydrate utilisation.		
2	Vegetative growth- Phases of growth, Factors affecting growth, Physiological effects and commercial applications of Auxins, Gibberellins, Cytokinins and Absciscic acid.		
UNIT III		15	
Genetics			
1	Genetic mapping in eukaryotes: discovery of genetic linkage, gene recombination, construction of genetic maps, three-point crosses and mapping chromosomes, problems based on the same.		
2	Gene mutations: definition, types of mutations, causes of mutations, Spontaneous and Induced mutations, The Ames's test.		
3	Metabolic disorders – enzymatic and non-enzymatic: Gene control of enzyme structure, Garrod's hypothesis of inborn errors of metabolism, Phenylketoneuria, albinism, sickle cell anaemia.		
UNIT IV		15	
Bioinformatics			
1	Protein structure analysis and application.		
2	Multiple sequence analysis and phylogenetic analysis.		

		L	Cr
Paper IV: CURRENT TRENDS IN PLANT SCIENCES II		Paper Code: RJSUBOT604	60
UNIT I		15	
Plant Biotechnology - II			
1	DNA sequence analysis – Maxam – Gilbert Method and Sanger's method		
2	Polymerase Chain reaction (PCR)- Technique, Applications, DNA typing.		
3	DNA barcoding: Basic features, nuclear genome sequence, chloroplast genome sequence, <i>rbcL</i> gene sequence, <i>matK</i> gene sequence, present status of barcoding in plants.		
UNIT II		15	
Plant Geography			
1	Phytogeographical regions of India.		
2	BIODIVERSITY : Definition, diversity of flora found in various forest types of India, Levels of biodiversity, Importance and status of biodiversity, Loss of biodiversity, Conservation of biodiversity, Genetic diversity- Molecular characteristics.		
UNIT III		15	
Economic Botany			
1	Essential Oils: Extraction, perfumes, perfume oils: oil of Rose, Patchouli, Champaca, grass oils: <i>Citronella</i> , Vetiver.		
2	Fatty oils: Drying oil (linseed and Soyabean oil), semidrying oils (Cotton seed, Sesame oil) and non-drying oils (Olive oil and Peanut oil).		
3	Vegetable Fats: Coconut and Palm oil.		
UNIT IV		15	
Post-Harvest Technology			
1	Storage of Plant Produce- Preservation of Fruits and Vegetables.		
2	Drying (Dehydration)- (Natural conditions – Sun drying; Artificial drying- hot air drying, Vacuum drying, Osmotically dried fruits, Crystallized or Candied fruits, Fruit Leather, Freeze Drying).		
3	Freezing (Cold air blast system, Liquid immersion method, Plate freezers, Cryogenic Freezing, Freeze drying).		
4	Canning. Pickling (in brine, in vinegar, Indian pickles). Sugar Concentrates (Jams, Jellies), Fruit juices.		
5	Food preservatives, Use of antioxidants in preservation		

Semester V (PRACTICALS)		L	Cr
Practical I PLANT DIVERSITY- III		Paper Code: RJSUBOTP501	2.5
	Microbiology		
1	Study of aeromicrobiota by petri plate exposed method - Fungal culture; Bacterial culture.		
2	Determination of Minimum Inhibitory Concentration (MIC) of sucrose against selected microorganism.		
3	Study of antimicrobial activity by the disc diffusion method		
	Algae		
1	Study of stages in the life cycle of the following Algae from fresh / preserved material and permanent slides: a) <i>Polysiphonia</i> b) <i>Vaucheria</i>		
	Fungi		
1	Study of stages in the life cycle of the following Fungi from fresh / preserved material and permanent slides: a) <i>Agaricus</i> b) <i>Puccinia</i> c) <i>Alternaria</i>		
	Plant Pathology		
	Study of the following fungal diseases: a) White rust b) Tikka disease in Groundnut c) Citrus canker d) Insect Pest disease- Aphids		
Practical II : PLANT DIVERSITY- IV		Paper Code: RJSUBOTP502	2.5
	Paleobotany		
	Study of the following form genera with the help of permanent slides/ photomicrographs: a) <i>Calamites</i> b) <i>Lepidodendron</i> c) <i>Lyginopteris</i> d) <i>Pentoxylon</i>		
	Angiosperms		
1	Morphology of Fruits- Simple, Aggregate and Composite.		
2	Study of one plant from each of the following Angiosperm families: a) Capparidaceae b) Umbelliferae c) Cucurbitaceae d) Rubiaceae e) Solanaceae		

	f) Commelinaceae g) Graminae		
3	Morphological peculiarities and economic importance of the members of the above-mentioned Angiosperm families.		
4	Identifying the genus and species of a plant with the help of Flora.		
	Anatomy I		
1	Study of anomalous secondary growth in the stems of the following plants using double staining technique: a) <i>Bignonia</i> b) <i>Salvadora</i> c) <i>Achyranthes</i> d) <i>Aristolochia</i> e) <i>Dracaena</i>		
2	Study of anomalous secondary growth in the roots of- a) Beet b) Radish		
3	Types of Stomata - a) Anomocytic b) Anisocytic c) Diacytic d) Paracytic e) Graminaceous		
	Palynology		
1	Study of pollen morphology (NPC Analysis) of the following by Chitale's Method: a) <i>Hibiscus</i> b) <i>Datura</i> c) <i>Ocimum</i> d) <i>Crinum</i> e) <i>Panocratium</i> f) <i>Canna</i>		
2	Determination of pollen viability.		
3	Pollen analysis from honey sample – unifloral and multifloral honey.		
4	Effect of varying concentration of sucrose on <i>In vitro</i> Pollen germination.		
PRACTICAL III - FORM AND FUNCTION - II		Paper Code: RJSUBOTP503	2.5
	<u>Cytology and Molecular Biology</u>		
1	Smear preparation from <i>Tradescantia</i> buds.		

	<u>PHYSIOLOGY</u>		
1	Estimation of Phosphate phosphorus (Plant acid extract).		
2	Estimation of Iron (Plant acid extract).		
	<u>ENVIRONMENTAL BOTANY</u>		
1	Estimation of the following in given water sample: a) Dissolved oxygen b) Biological oxygen demand c) Total Hardness d) Salinity and Chlorinity		
2	Plant Tissue culture II:		
	1. Preparation of stock solutions for preparation of MS medium.		
	2. Identification – Multiple shoot culture, hairy root culture, somatic embryogenesis.		
Practical IV - CURRENT TRENDS IN PLANT SCIENCES – II		Paper Code: RJSUBOTP504	2.5
	Ethnobotany and Mushroom cultivation		
1	Study of plants mentioned in theory for Ethnobotany.		
2	Mushroom cultivation		
3	Identification of various stages involved in mushroom cultivation – spawn, pin head stage, mature/ harvest stage of <i>Agaricus</i> , <i>Pleurotus</i> .		
	Biotechnology- I		
1	Study of Growth curve of <i>E. coli</i> .		
2	Isolation of Plasmid DNA and Separation of DNA using AGE.		
3	Restriction mapping (problems) and Southern blotting.		
	<u>Instrumentation</u>		
1	Experiment based on ion exchange chromatography for demonstration.		
2	Experiment based on separation of dyes/ plant pigments using silica gel column.		
	Pharmacognosy		
1	Macroscopic/ Microscopic characters and Chemical tests for active constituents of the following plants: a) <i>Allium sativum</i> b) <i>Acorus calamus</i> c) <i>Curcuma longa</i> d) <i>Strychnos nux-vomica</i> e) <i>Eugenia caryophyllata</i>		

	SEMESTER VI (PRACTICALS)			
Practical I - PLANT DIVERSITY- III		Paper Code: RJSUBOTP601		2.5
	Bryophyta			
1	Study of stages in the life cycle of the following Bryophyta from fresh / preserved material and permanent slides a) <i>Marchantia</i> b) <i>Pellia</i>			
	Pteridophyta			
1	Study of stages in the life cycles of the following Pteridophytes from fresh / preserved material and permanent slides :- a) <i>Lycopodium</i> b) <i>Equisetum</i>			
	Bryophytes and Pteridophytes: Applied aspects			
1	Economic importance of Bryophytes.			
2	Economic importance of Pteridophytes.			
3	Types of sporophytes in Bryophytes (from Permanent slides).			
	Gymnosperms			
1	Study of stages in the life cycles of the following Gymnosperms from fresh / preserved material and permanent slides: a) <i>Thuja/ Biota</i> b) <i>Gnetum</i> c) <i>Ephedra</i>			
Practical - II : PLANT DIVERSITY- IV		Paper Code: RJSUBOTP602		2.5
	Angiosperms			
1	Study of one plant from each of the following Angiosperm families: a) Rhamnaceae b) Combretaceae c) Asclepiadaceae d) Labiatae e) Euphorbiaceae f) Cannaceae			
2	Morphological peculiarities and economic importance of the members of the above-mentioned Angiosperm families.			
3	Identify the genus and species with the help of flora.			
	Anatomy			
1	Study of Ecological Anatomy of : a) Hydrophytes: <i>Hydrilla</i> stem, <i>Nymphaea</i> petiole, <i>Eichhornia</i> offset b) Epiphytes: Orchid c) Sciophytes: <i>Peperomia</i> leaf d) Xerophytes: <i>Nerium</i> leaf, <i>Opuntia</i> phylloclade			

	e) Halophytes: <i>Avicennia</i> leaf and pneumatophore, <i>Sessuvium</i> / <i>Suaeda</i> leaf f) Mesophytes: <i>Vinca</i> leaf		
	Embryology		
1	Study of various stages of Microsporogenesis, Megasporogenesis and Embryo Development with the help of permanent slides / photomicrographs.		
2	Mounting of Monocot (Maize) and Dicot (Castor and Gram) embryo.		
3	<i>In vivo</i> growth of pollen tube in <i>Portulaca/Vinca</i> .		
	Biostatistics II		
1	Problems based on <i>t</i> -test (paired and unpaired).		
2	Problems based on regression analysis.		
3	Problems based on ANOVA.		
Practical- III FORM AND FUNCTION – III		Paper Code: RJSUBOTP603	2.5
	Plant Biochemistry		
1	Estimation of proteins by Biuret method.		
2	Effect of pH on the activity of amylase.		
3	Effect of substrate variation on the activity of amylase.		
	Plant Physiology		
1	Determination of alpha-amino nitrogen.		
2	Effect of GA on seed germination.		
	Genetics		
1	Problems based on three-point crosses, construction of chromosome maps.		
2	Identification of types of mutations from given DNA sequences.		
3	Study of mitosis using pre-treated root tips of <i>Allium</i> .		
	Bioinformatics		
1	Protein structure analysis and application		
2	Multiple sequence analysis and phylogenetic analysis		

Practical- IV : CURRENT TRENDS IN PLANT SCIENCES- II		Paper Code: RJSUBOTP604		
	Plant Biotechnology II			
1	DNA sequencing - Maxam-Gilbert Method by using an autoradiogram			
2	DNA barcoding of plant material by using suitable data.			
	Plant Geography			
1	Study of phyto geographical regions of India.			
2	Preparation of vegetation map using Garmin's GPS Instrument.			
3	Problems based on Simpson's diversity Index.			
	Economic Botany			
1	Demonstration: Extraction of essential oil using Clevenger.			
2	Thin layer chromatography of essential oil of Patchouli and <i>Citronella</i> .			
3	Saponification value of Palm oil.			
	Post-Harvest Technology			
1	Preparation of: a) Squash b) Jam c) Jelly d) Pickle.			

T.Y.BSc	Semester V Theory
RJSUBOT501 Paper I Plant Diversity III	<p>Course Outcomes 5.1 :</p> <ol style="list-style-type: none"> 1. Microbiology studies – various microbes, media type and composition, staining, colony characters. 2. Pure cultures and Role of microbes in fermentation. 3. Detailed study of algae (<i>Rhodophyta</i> and <i>Xanthophyceae</i>) and fungi (Basidiomycetes and Deuteromycetes) 4. Study of Systematic position, Life cycle and Alternation of generations of algae (<i>Polysiphonia</i>, and <i>Vaucheria</i>) and fungi (<i>Agaricus</i>, <i>Puccinia</i> and <i>Alternaria</i>.) 5. Study of plant diseases and Physical, chemical and biological control methods of plant diseases. <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Microbiology studies. ➤ Understanding classical botany and application. ➤ Knowing the cause and control of plant diseases.

T.Y.BSc	Semester V Theory
RJSUBOT502 Paper II Plant Diversity- IV	<p>Course Outcomes 5.2 :</p> <ol style="list-style-type: none"> 1. Exploring palaeobotany with studies of <i>Calamites</i>, <i>Lepidodendron</i>, <i>Lyginopteris</i>, <i>Pentoxylon</i> and contributions of Birbal Sahni (Birbal Sahni Institute of Paleobotany, Lucknow.) 2. Detailed study of Morphology of fruit, Complete classification of Bentham and Hooker : Merits and demerits, system of classification for flowering plants up to family of Capparidaceae, Umbelliferae, Cucurbitaceae, Rubiaceae, Solanaceae, Commelinaceae and Graminae. 3. Study of anomalous secondary growth in the stems and roots, root-stem transition and types of stomata. 4. Study of pollen morphology, viability, germination and growth of pollen and application of palynology. <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Understanding the past environment with the help of palaeobotany. ➤ Learning of Bentham and Hooker classification. ➤ Knowing the anomalous secondary growth in reinforcement of tall plants ➤ Understanding the pollen specificity.

T.Y.BSc	Semester V Theory
RJSUBOT503 Paper-III Forms and functions – III	<p>Course Outcomes 5.3 :</p> <ol style="list-style-type: none"> 1. Detailed study of nucleus, vacuole and functions of giant chromosomes. 2. Mechanism of Transcription and Translation in Prokaryotes and Eukaryotes and Characteristics of the genetic code. 3. Understanding Plant- Water relations with Solute transport and Translocation. 4. Study of bioremediation and phytoremediation. 5. Study of plant succession. 6. Understanding the role of micropropagation in plant cell suspension, secondary metabolites, Somatic embryogenesis, artificial seeds, Protoplast fusion and Somatic hybridization. <p>Learning outcomes : (Research orientation, skill development)</p> <ul style="list-style-type: none"> ➤ Basic concepts of molecular biology. ➤ Understanding solute transport and translocation in plants. ➤ Use of bioremediation and phytoremediation. ➤ Applications of plant tissue culture and micropropagation.

T.Y.Bsc	Semester V theory
RJSUBOT504 Paper- IV Current trends in Plant science- II	<p>Course outcomes 5.4 :</p> <ol style="list-style-type: none"> 1. Detailed study of ethnobotany and traditional medicines. 2. Exploring mushroom cultivation and its nutritional value. 3. Understanding cDNA libraries, restriction enzyme, analysis of cloned DNA sequences and southern hybridisation. 4. Detailed study of instrumentation techniques colorimetry, spectrophotometry (visible, UV and IR), column chromatography, adsorption and partition chromatography, ion exchange chromatography, molecular sieve chromatography 5. Pharmacognosy study of <i>Strychnos</i> seeds, Clove buds, <i>Allium sativum</i>, <i>Acorus calamus</i> and <i>Curcuma longa</i>. <p>Learning outcome : (Skill development and entrepreneurship)</p> <ul style="list-style-type: none"> ➤ Understanding ethnobotany and traditional medicines. ➤ Motivation of Entrepreneurship in mushroom cultivation. ➤ Basic concept of molecular biology. ➤ Learning analytical techniques. ➤ Pharmacognosy study.

T.Y.BSc	Semester V Practical Skill development
RJSUBOTP501 Practical I Plant Diversity III	<p>Course Outcomes 5.1:</p> <ol style="list-style-type: none"> 1. Detailed study of Aeromicrobiota, Minimum Inhibitory Concentration (MIC) and antimicrobial activity. 2. Study of stages in the life cycle algae (<i>Polysiphonia</i> and <i>Vaucheria</i>) and fungi (<i>Agaricus</i>, <i>Puccinia</i> and <i>Alternaria</i>). 3. Detailed study of the fungal diseases (White rust, Tikka disease in Groundnut and Citrus canker). <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Microbiology study. ➤ Understanding classical botany and its application. ➤ Detailed study of causative agent of plant diseases.

T.Y.BSc	Semester V Practical Skill development, experiential learning, planning.
RJSUBOTP502 Practical II Plant Diversity- IV	<p>Course Outcomes 5.2:</p> <ol style="list-style-type: none"> 1. Study of palaeobotany with studies of <i>Calamites</i>, <i>Lepidodendron</i>, <i>Lyginopteris</i> and, <i>Pentoxylon</i>. 2. Study of different types of fruits, detailed study of <i>Capparidaceae</i>, <i>Umbelliferae</i>, <i>Cucurbitaceae</i>, <i>Rubiaceae</i>, <i>Solanaceae</i>, <i>Commelinaceae</i> and <i>Graminae</i>. 3. Identifying the genus and species of a plant with the help of Flora. 4. Study of anomalous secondary growth with double staining in the stems (<i>Bignonia</i>, <i>Salvadora</i>, <i>Achyranthes</i>, <i>Aristolochia</i> and <i>Dracaena</i>) and roots of beet and radish. 5. Study of types of stomata. 6. Study of pollen morphology (NPC analysis), viability and effect of varying concentration of sucrose on <i>In vitro</i> pollen germination and pollen analysis from honey sample. <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Understanding the past environment with the help of palaeobotany. ➤ Learning of Angiosperm's taxonomy. ➤ Learning of double staining technique. ➤ Understanding the pollen specificity and NPC analysis.

T.Y.BSc	Semester V Practical Skill based training
RJSUBOTP503 Practical III Forms And Functions – III	<p>Course Outcomes 5.3:</p> <ol style="list-style-type: none"> 1. Study of meiosis in <i>Tradescantia</i> buds. 2. Estimation of Phosphate phosphorus and Iron from plant acid extract. 3. Estimation of Dissolved oxygen, Biological oxygen demand, Total Hardness and Salinity and Chlorinity in given water sample. 4. Understanding plant tissue culture and preparation of stock solutions for preparation of MS medium. <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Understanding the stages of meiosis. ➤ Assessment of Phosphate phosphorus and Iron content in plants. ➤ Assessment of water quality. ➤ Understanding basics of Plant Tissue Culture and preparation of stock solutions.

T.Y.BSc	Semester V Practical
RJSUBOTP504 Practical IV Current trends in plant science- II	<p>Course Outcomes 5.4: Tribal knowledge, ethics, entrepreneurship, research orientation</p> <ol style="list-style-type: none"> 1. Study of plants for Ethnobotany. 2. Mushroom cultivation. 3. Analysis of Growth curve of <i>E. coli</i>. 4. Plasmid DNA isolation and separation of DNA using AGE and understanding restriction mapping (problems), southern blotting. 5. Study of macroscopic/ microscopic characters and Chemical tests for active constituents of <i>Allium sativum</i>, <i>Acorus calamus</i>, <i>Curcuma longa</i>, <i>Strychnos nux-vomica</i> and <i>Eugenia caryophyllata</i>. <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Understanding Ethno botany and traditional medicines. (Understanding and applications of traditional knowledge and scientific understanding). ➤ Motivation of Entrepreneurship in mushroom cultivation. ➤ Determination of generation time of <i>E. coli</i>. ➤ Learning analytical techniques. ➤ Pharmacognosy study of macroscopic/ microscopic characters of the above mentioned plants.

T.Y.BSc	Semester VI Theory
RJSUBOT601 Paper 1 Plant Diversity III	<p>Course Outcomes 6.1:</p> <ol style="list-style-type: none"> 1. Detailed study of Bryophyta (<i>Marchantia</i>, <i>Pellia</i>) and Pteridophyta (<i>Lycopodium</i>, Calamophyta, <i>Equisetum</i>) 2. Study of Bryophytes in aspect of ecology, economic importance, ecological indicators and evolution of sporophyte and gametophyte. 3. Study of Pteridophyte's economic importance, diversity and distribution. 4. Detailed study of gymnosperms (<i>Thuja</i>, <i>Gnetum</i> and <i>Ephedra</i>). <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Understanding Bryophytes and Pteridophytes and their applications. ➤ Recognising the benefits of gymnosperms.

T.Y.BSc	Semester VI Theory
RJSUBOT602 Paper 2 Plant Diversity- IV	<p>Course Outcomes 6.2 :</p> <ol style="list-style-type: none"> 1. Study of major botanical gardens of India, Botanical Survey of India and regional plants of India. 2. Detailed study of angiosperm families (<i>Rhamnaceae</i>, <i>Combretaceae</i>, <i>Asclepiadaceae</i>, <i>Labiatae</i>, <i>Euphorbiaceae</i> and <i>Cannaceae</i>) and Hutchinson's classification. 3. Anatomical study of hydrophytes, hygrophytes, mesophytes, sciophytes, halophytes, epiphytes and xerophytes. 4. Development study of microsporogenesis and megasporogenesis and embryo. 5. Analysis of data by Student's t-Test, Regression and ANOVA (one way). <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Introduction of Indian regional flora. ➤ Detailed study of some angiosperms families. ➤ Study of plant adaptations in different environment. ➤ Plant development study. ➤ Bio-statistical analysis of data.

T.Y.BSc	Semester VI Theory
RJSUBOT603 Paper-III Forms and Functions – III	<p>Course Outcomes 6.3 :</p> <ol style="list-style-type: none"> 1. Study of biomolecules: Carbohydrates (sugars, starch, cellulose, pectin), Lipids (fatty acids and glycerol), Proteins (amino acids). 2. Detailed study of enzymes and it's mechanism. 3. Detailed study of plant nitrogen metabolism, vegetative growth and commercial applications PGR. 4. Understanding eukaryotic genetic mapping, gene mutations, metabolic disorders – enzymatic and non-enzymatic. 5. Study of bioinformatics application (protein structure analysis and application, multiple sequence analysis and phylogenetic analysis). <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Understanding macromolecules and enzymes application. ➤ Some concept learning of plant physiology and molecular biology. ➤ Bioinformatics application. Computational biology

T.Y.BSc	Semester VI theory
RJSUBOT604 Paper-IV Current trends in Plant Science- II	<p>Course Outcomes 6.4 :</p> <ol style="list-style-type: none"> 1. Detailed study of DNA sequence analysis, Polymerase Chain Reaction and DNA barcoding. 2. Study of biodiversity and phytogeographical regions of India. 3. Detailed study of Essential Oils, Fatty oils and Vegetable Fats. 4. Study of post-harvest technology (storage, drying, freezing, canning and food preservatives). <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Concept of molecular biology of DNA. ➤ Knowing biodiversity and phytogeographical regions of India. ➤ Understanding the application of oils and fats and post-harvest technology (Entrepreneurship).

T.Y.BSc	Semester VI Practical Skill Development
RJSUBOTP601 Practical I Plant Diversity III	<p>Course Outcomes 6.1:</p> <ol style="list-style-type: none"> 1. Slide preparation/ permanent slides study of <i>Bryophyta</i> (<i>Marchantia</i>, <i>Pellia</i>) and <i>Pteridophyta</i> (<i>Lycopodium</i> and <i>Equisetum</i>). 2. Study of types of sporophytes in Bryophytes. 3. Detailed study of gymnosperms (<i>Thuja</i>, <i>Gnetum</i> and <i>Ephedra</i>) and its economic importance. <p>Learning outcome :</p> <ul style="list-style-type: none"> ➤ Understanding the detailed morphology of Bryophyta and Pteridophyta. To understand their role in plant succession. ➤ Recognising the benefits of gymnosperms.

T.Y.BSc	Semester VI Practical: Skill enhancement, experiential learning, Application in field studies
RJSUBOTP602 Practical II Plant Diversity- IV	<p>Course Outcomes 6.2:</p> <ol style="list-style-type: none"> 1. Study of angiosperm families (<i>Rhamnaceae</i>, <i>Combretaceae</i>, <i>Asclepiadaceae</i>, <i>Labiatae</i>, <i>Euphorbiaceae</i> and <i>Cannaceae</i>) 2. Identify the genus and species with the help of flora. 3. Anatomical sectional study of hydrophytes, mesophytes, sciophytes, halophytes, epiphytes and xerophytes. 4. Study of various stages of microsporogenesis and megasporogenesis, embryo and <i>In vivo</i> growth of pollen tube 5. Analysis of data given by Student's t-Test, Regression and ANOVA (one way). <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Detailed study of some angiosperm families. ➤ Anatomical study of plant adaptations in different environment. ➤ Study of plant development stages. ➤ Bio-statistical analysis of data.

T.Y.BSc	Semester VI Practical: Skill development, research orientation, experimental design
RJSUBOTP603 Practical III Forms And Functions – III	<p>Course Outcome 6.3:</p> <ol style="list-style-type: none"> 1. Estimation of proteins from sample. 2. Study the effect of pH and substrate variation on the activity of amylase. 3. Estimation of alpha-amino nitrogen and effect of GA₃ on seed germination. 4. Analysis of problems based on three-point crosses, construction of chromosome maps. 5. Identification of types of mutations from given DNA sequences. 6. Study of mitosis using pre-treated root tips of <i>Allium</i>. 7. Experiments based on Bioinformatics. <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Understanding enzymology application. ➤ Nutritional value finding ➤ Mapping of gene and construction of chromosome maps. ➤ Mutation effect study. ➤ Computational skills

T.Y.BSc	Semester VI Practical : Entrepreneurship
RJSUBOTP604 Practical IV Current trends in Plant Science- II	<p>Course Outcomes 6.4:</p> <ol style="list-style-type: none"> 1. DNA sequencing and barcoding of plant material 2. Study of phytogeographical regions of India, vegetation map using Garmin's GPS Instrument. 3. Analysis of problems based on Simpson's diversity Index. 4. Distillate extraction of essential oil using Clevenger and application of thin layer chromatography. 5. Estimation of saponification value of palm oil. 6. Preparation of Squash, Jam, Jelly and Pickle. <p>Learning outcomes :</p> <ul style="list-style-type: none"> ➤ Molecular identification of plant material. ➤ Tree census study. ➤ Distillate application in perfumery. ➤ Entrepreneurship in post-harvest technology.

Scheme of Examinations

1. Two Internals of 20 marks each. Duration 20min for each.
2. One External (Semester End Examination) of 60 marks. Duration 2 hours.
3. One Practical at the end of Semester consisting of Practical I 50 marks, Practical II 50 marks, Practical III 50 marks and Practical IV 50 marks but passing combined out of 200.
4. Minimum marks for passing Semester End Theory and Practical Exam is 40 %.
5. Student must appear at least one of the two Internal Tests to be eligible for the Semester End Examination.
6. Two short field excursions for habitat studies are compulsory. Field report submission is mandatory
7. Field work of not less than eight hours duration is equivalent to one period per week for a batch of 15 students.
8. A candidate will be allowed to appear for the practical examinations if he/she submits a certified journal of T.Y.B.Sc. Botany or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of T.Y.B.Sc. Botany as per the minimum requirements.
9. In case of loss of journal, a candidate must produce a certificate from the Head of the department /Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination but the marks allotted for the journal will not be granted.
10. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

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