UNIVERSITY OF MUMBAI
No. UG/95 of 2015-16

CIRCULAR:-

A reference is invited to the Syllabi relating to the B.Sc. degree program, **vide** this office Circular No. UG/140 of 2010, dated 29th June, 2010 and the Principals of affiliated Colleges in Science are hereby informed that the recommendation made by the Faculty of Science at its meeting held on 22nd June, 2015 has been accepted by the Academic Council at its meeting held on 26th June, 2015 **vide** item No. 4.5 and that in accordance therewith, the revised syllabus as per Credit Based Semester and Grading System for the Third Year B.Sc. Botany (Sem.V & VI), which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

MUMBAI – 400 032
5th October, 2015

REGISTRAR

To,

The Principals of affiliated Colleges in Science.

A.C/4.5/26/06/2015

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No. UG/95-A of 2015-16 MUMBAI-400 032 5th October, 2015

Copy forwarded with compliments for information to :-

1) The Dean, Faculty of Science.
2) The Director, Board of Colleges and University Development,
3) The Professor-cum-Director, Institute of Distance an Open Learning (IDOL),
4) The Controller of Examinations,
5) The Co-Ordinator, University Computerization Centre.

5/10/15

REGISTRAR

..PTO

AC 26/06/2015
Item No. 4.5

UNIVERSITY OF MUMBAI

Syllabus for the T.Y.B.Sc.
Program: B.Sc.
Course: BOTANY

(Credit Based Semester and Grading System with effect from the academic year 2016–2017)

T.Y.B.Sc. Botany Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2016-2017
SEMESTER V

Course Code	UNIT	TOPICS	Credits	L / Week
USBO501	PLANT DIVERSITY III			
	I	Algae	2.5	1
	II	Fungi		1
	III	Plant Pathology		1
	IV	Microbiology		1
USBO502	PLANT DIVERSITY IV			
	I	Paleo botany	2.5	1
	II	Angiosperms I		1
	III	Anatomy I		1
	IV	Palynology		1
USBO503	FORM AND FUNCTION III			
	I	Cytology and Molecular Biology	2.5	1
	II	Physiology I		1
	III	Environmental Botany		1
	IV	Biostatistics		1
USBO504	CURRENT TRENDS IN PLANT SCIENCESII			
	I	Food as medicine and Nutrition and the Mushroom Industry	2.5	1
	II	Plant Tissue Culture		1
	III	Instrumentation		1
	IV	Pharmacognosy& Medicinal Botany		1
USBOP5	Practical based on all the four courses in theory		6	16

SEMESTER VI

Course Code	UNIT	TOPICS	Credits	L / Week
USBO601	**PLANT DIVERSITY III**			
	I	Bryophyta	2.5	1
	II	Pteridophyta		1
	III	Biotechnology I		1
	IV	Biotechnology II		1
USBO602	**PLANT DIVERSITY IV**			
	I	Gymnosperms	2.5	1
	II	Angiosperms II		1
	III	Anatomy II		1
	IV	Embryology		1
USBO603	**FORM AND FUNCTION III**			
	I	Genetics	2.5	1
	II	Physiology II		1
	III	Bioinformatics		1
	IV	Horticulture and Cosmetology		1
USBO604	**CURRENT TRENDS IN PLANT SCIENCES II**			
	I	Ethnobotany and Aesthetic Botany	2.5	1
	II	Plant Geography and Environmental Botany		1
	III	Economic Botany		1
	IV	Post Harvest Technology		1
USBOP6	Practical based on all the four courses in theory		6	16

SEMESTER V
THEORY

Course Code	Title	Credits
USBO501	**PLANT DIVERSITTY III**	**2.5 Credits (60 lectures)**
Unit I : Algae 1. Division Rhodophyta Classification and General Characters: Distribution, Cell structure, pigments, reserve food, range of thallus, reproduction: asexual and sexual, Alternation of Generations, Economic Importance. Structure, life cycle and systematic position of *Polysiphonia* *Batrachospermum* 2. Division Chrysophyta Classification and General Characters of Xanthophyta: Distribution, Cell structure, pigments, reserve food, range of thallus, Reproduction: asexual and sexual, Alternation of Generations, Economic Importance. Structure, life cycle and systematic position of *Vaucheria* Classification and General Characters of Bacillariophyta: Distribution, Cell structure, pigments, reserve food, range of thallus, Reproduction: asexual and sexual, Alternation of Generations, Economic Importance. Structure, life cycle and systematic position of *Pinnularia*		15 Lectures
Unit II : Fungi • Basidiomycetes: Classification and General characters • Life cycle of *Agaricus* • Life cycle of *Puccinia* • Deuteromycetae: Classification and General Characters • Life cycle of *Alternaria*		**15 Lectures**

Unit III : Plant Pathology
• Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures of the following.
  • Loose smut of Jowar: *Spacelothecasorghi*
  • Tikka disease of ground nut: *Cercospora*
  • Damping off disease: *Pythium*
		15 Lectures

Unit IV: Microbiology • Types of Microbes • Culturing: Sterilization, media, staining, colony characters • Pure culture • Role of microbes in fermentation: Alcohol and Antibiotics	**15 Lectures**

Course Code	Title	Credits
USBO502	**PLANT DIVERSITY IV**	**2.5 Credits (60 lectures)**
Unit I : Paleobotany • *Lepidodendron*–All form genera root, stem, bark, leaf, male and female fructification • *Lyginopteris* – All form genera root, stem, leaf, male and female fructification • *Pentoxylon* – All form genera • Contribution of BirbalSahni, BirbalSahni Institute of Paleobotany, Lucknow		**15 Lectures**
Unit II : Angiosperms I • Characters of Taxonomic Importance – Morphology, Anatomy, Chemotaxonomy, Palynology • Complete classification of Bentham and Hooker(only for prescribed families), Merits and demerits • 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 • Capparidaceae • Umbelliferae • Cucurbitaceae • Rubiaceae • Solanaceae • Commelinaceae • Graminae		**15 Lectures**
Unit III : Anatomy • Anomalous secondary growth in the Stems of *Bignonia*, *Salvadora*, *Achyranthes*, *Aristolochia*, *Dracaena*. Storage roots of Beet, Radish • Root stem transition • Types of Stomata – Anomocytic, Anisocytic, Diacytic, Paracytic, and Graminaceous.		**15 Lectures**
Unit IV : Palynology • Pollen Morphology • Pollen viability – storage • Germination and growth of pollen		**15 Lectures**

• Applications of Palynology in Taxonomy, Honey Industry,Coal and oil exploration, Aerobiology and Pollen Allergies, Forensic Science.		
Course Code	Title	Credits
USBO503	**FORM AND FUNCTION III**	**2.5 Credits (60 lectures)**
Unit I : Cytology and Molecular Biology • Structure and function of nucleus (Complete detail) • Structure and function of vacuole • Structure and function of giant chromosomes • The Genetic Code- characteristics of the Genetic Code • Translation in prokaryotes and eukaryotes		**15 Lectures**
Unit II : Physiology I • Water relations – potential, osmosis, transpiration, imbibition, transport • Mineral Nutrition: Macro and micronutrients, criteria of essentiality of elements, role of essential elements, transport of ions across cell membranes, active and passive transport, carriers, channels and pumps. • Translocation of solutes Composition of phloem sap, girdling experiment, pressure flow model, phloem loading and unloading. Mechanisms of sieve tube translocation. • Vegetative Growth: Generalphases of growth, Growth Curves, Factors affecting growth – External (environmental) and internal (genetic, hormonal, nutritional); Role of plant growth regulating substances – Auxins, Cytokinins and Gibberellins and their commercial applications.		**15 Lectures**
Unit III : Environmental Botany • Bioremediation: Principles, Factors responsible and Microbial population in bioremediation. • Biomagnifications. • Bioaccumulation and Biotransformation. • Phytoremediation: Metals, Organic pollutants.		**15 Lectures**
Unit IV : Biostatistics • Test of significance student's *t*-test (paired and unpaired) • Regression • ANOVA (one way)		**15 Lectures**

Course Code	Title	Credits
USBO504	**CURTRENT TRENDS IN PLANT SCIENCES II**	**2.5 Credits (60 lectures)**
Unit I : Food as Medicine and Nutrition and Mushroom Industry • Dietary antioxidants • Food as medicine - Anaemia, Diabetes, Obesity, Skin disorders. • Mushroom industry (*Pleurotus*) – Cultivation, types, picking and packaging, marketing and economics of the business.		**15 Lectures**
Unit II : Plant Tissue Culture • Aspects of micropropagation with reference to floriculture • Plant cell suspension cultures for the production of secondary metabolites • Somatic embryogenensis and artificial seeds • Protoplast Fusion and Somatic Hybridization		**15 Lectures**
Unit III : Instrumentation • Colorimetry and spectrophotometry (only visible but mention UV and IR) – Instrumentation, working, principle and applications • Chromatography –Column – ion exchange, HPLC		**15 Lectures**
Unit IV : Pharmacognosy& Medicinal Botany • Cultivation practices with reference to soil, propagation methods, irrigation, manuring, harvesting, processing, storage, pests and diseases and marketing – *Allium sativum, Acoruscalamus, Curcuma longa*. • Monographs of drugs with reference to biological sources, geographical distribution, common varieties, macro and microscopic characters, chemical constituents, therapeutic uses, adulterants – *Strychnos* seeds, Senna leaf, Clove buds.		**15 Lectures**

SEMESTER V
PRACTICAL

Semester V USBOP5	Cr
PRACTICAL Paper I – PLANT DIVERSITY III	**1.5**
Algae	
Study of stages in the life cycle of the following Algae from fresh / preserved material and permanent slides • *Polysiphonia* • *Batrachospermum* • *Vaucheria* • *Pinnularia*	
Fungi	
Study of stages in the life cycle of the following Fungi from fresh / preserved material and permanent slides • *Agaricus* • *Puccinia* • *Alternaria*	
Plant Pathology	
Study of the following fungal diseases: • Loose smut • Tikka disease in Groundnut • Damping off disease	
Microbiology	
• Study of aeromicrobiota by petriplate exposed method Fungal culture Bacterial culture • Determination of Minimum Inhibitory Concentration (MIC) of sucrose against selected micro organism • Study of antimicrobial activity by the disc diffusion method	
PRACTICAL Paper II – PLANT DIVERSITY IV	**1.5**
Paleobotany	
Study of the following form genera with the help of permanent slides / photomicrographs • *Lepidodendron* (All form genera, whichever available) • *Lyginopteris* • *Pentoxylon*	
Angiosperms	
Study of one plant from each of the following Angiosperm families • Capparidaceae	

• Umbelliferae • Cucurbitaceae • Rubiacae • Solanaceae • Commelinaceae • Graminae	
Morphological peculiarities and economic importance of the members of the above mentioned Angiosperm families	
Identifying the genus and species of a plant with the help of Flora	
Anatomy I	
Study of anomalous secondary growth in the stems of the following plants using double staining technique • *Bignonia* • *Salvadora* • *Achyranthes* • *Aristolochia* • *Dracaena* Study of anomalous secondary growth in the roots of • Beet • Radish Types of Stomata • Anomocytic • Anisocytic • Diacytic • Paracytic • Graminaceous	
Palynology	
Study of pollen morphology (NPC Analysis) of the following by Chitley's Method • *Hibiscus* • *Datura* • *Oscimum* • *Crinum* • *Pancratium* • *Canna* Determination of pollen viability Pollen analysis from honey sample – unifloral and multifloral honey Effect of varying concentration of sucrose on *In vitro* Pollen germination	
PRACTICAL - Paper III FORM AND FUNCTION III	**1.5**
Cytology and Molecular Biology	
Mounting of giant chromosome from *Chironomous* larva Smear preparation from *Tradescantia* buds Predicting the sequence of Amino acids in the polypeptide chain that will be	

formed following translation.(Prokaryotic and Eukaryotic)	
Plant Physiology and Biochemistry	
Estimation of phosphate phosphorus (plant acid extract) Estimation of iron (plant acid extract)	
Environmental Botany	
Estimation of the following in / of the given water sample: • Dissolved Oxygen Demand • Biological Oxygen Demand • Hardness • Salinity • Acidity • Alkalinity	
Biostatistics	
t-test (paired and unpaired) Problems based on regression analysis ANOVA	
PRACTICAL - Paper IV CURRENT TRENDS IN PLANT SCIENCES II	**1.5**
Food as medicine and nutrition &Mushroom Cultivation	
Mushroom cultivation (demonstration) – identification of various steps involved (spawn, pin head stage and mature stage)	
Micropropagation	
Plant Tissue Culture • Various sterilization techniques, preparation of stock solutions, preparation of MS medium • Seed sterilization, callus induction and regeneration • Encapsulation of axillary buds	
Instrumentation	
Beer-Lambert's law Experiment based on ion exchange	
Pharmacognosy	
Chemical tests for the active constituents of the following plants • *Allium sativum* • *Acoruscalamus* • *Curcuma longa* • *Senna angustifolia* • *Strychnosnux-vomica* • *Eugenia caryophyllata*	
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SEMESTER VI
THEORY

Course Code	Title	Credits
USBO601	**PLANT DIVERSITY III**	**2.5 Credits (60 lectures)**
Unit I : Bryophyta • Life cycle of *Marchantia* • Evolution of sporophyte • Evolution of gametophyte		**15 Lectures**
Unit II : Pteridophyta • Calamophyta – Classification, general characters, *Calamites*; Life cycle of *Equisetum* • Pterophyta – Classification and general characters, Life cycle of *Marsilia* • Types of sori and evolution of sori		**15 Lectures**
Unit III : Plant Biotechnology I • Construction of Genomic DNA libraries, Chromosome libraries and c-DNA Libraries. • Identification of specific cloned sequences in cDNA libraries and Genomic libraries. • Analysis of genes and gene transcripts – Restriction enzyme analysis of cloned DNA sequences. • Hybridization (Southern Hybridization).		**15 Lectures**
Unit IV : Plant Biotechnology II • DNA sequence analysis – Maxam – Gilbert Method and Sanger's method • Polymerase chain reaction • DNA barcoding: basic features, nuclear genome sequence, chloroplast genome sequence, *rbc*L gene sequence, *mat*K gene sequence, present status of barcoding in plants.		**15 Lectures**

Course Code	Title	Credits
USBO602	**PLANT DIVERSITY IV**	**2.5 Credits (60 lectures)**
Unit I : Gymnosperms • Gnetopsida – Classification • Life cycle of *Gnetum* • Life cycle of *Ephedra*		**15 Lectures**
Unit II : Angiosperms • Taxonomic literature - Library, Floras, Monographs, Dictionary, Periodicals, Index and Journals • Study of following plant families • Combretaceae • Rhamnaceae • Asclepiadaceae • Labiatae • Euphorbiaceae • Cannaceae Hutchinson's classification – merits and demerits		**15 Lectures**
Unit III : Anatomy Ecological anatomy • Hydrophytes – submerged, floating, rooted • Hygrophytes - *Typha* • Mesophytes • Sciophytes • Halophytes • Epiphytes • Xerophytes		**15 Lectures**
Unit IV : Embryology • Microsporogenesis • Megasporogenesis - Development of monosporic type, examples of all embryo sacs • Types of ovules • Double fertilization • Development of embryo - *Capsella*		

Course Code	Title	Credits
USBO603	**FORM AND FUNCTION III**	**2.5 Credits (60 lectures)**
Unit I : Physiology • Structure of biomolecules - carbohydrates (sugars, starch, cellulose, pectin), lipids (fatty acids, glycerol), proteins (amino acids) • **Enzymes -** Nomenclature, classification, mode of action, enzyme kinetics, MichaelisMenten equation, competitive, non competitiveand uncompetitive inhibitors • **Nitrogen Metabolism** NitrogenCycle, Root nodule formation and Leg- haemoglobin, Nitrogenase activity, Assimilation of nitrates (NR,NiRactivity), Assimilation of Ammonia (Amination and Transamination reactions), Nitrogen Assimilation and Carbohydrate utilization.		**15 Lectures**
Unit II : Genetics • Genetic mapping in eukaryotes: discovery of genetic linkage, gene recombination, construction of genetic maps, three point crosses and mapping chromosomes • Gene mutations: definition, types of mutations, reverse and spontaneous mutations, causes of mutations, induced mutations, the Aimes test, DNA repair mechanism • Metabolic disorders – enzymatic and non enzymatic: Gene control of enzyme structure Garrod's hypothesis of inborn errors of metabolism, Phenyl ketone urea, albinism, sickle cell anaemia		**15 Lectures**
Unit III : Bioinformatics • Organization of biological data, databases • Exploration of data bases, retrieval of desired data, BLAST. • Protein structure analysis and application • Multiple sequence analysis and phylogenetic analysis		**15 Lectures**
Unit IV : Herbal Cosmetology • **Plant antioxidants:** Free radicals, sources of free radicals, types of free radicals, antioxidant defence; Superoxide dismutase, catalase, antioxidant vitamins; vitamin C and E.Use of antioxidants in cosmetics. • **Application of herbs in the following herbal cosmetics** • Herbal Shampoo • Herbal Hair Dye/ Herbal Hair Oil/Hair Cream/Hair Gel • Herbal Face Mask • Herbal Bath Oil Current status of Herbal Cosmetic Industry in India, Problems and Future prospects of Herbal Cosmetic Industry in India.		**15 Lectures**

Course Code	Title	Credits
USBO604	**CURRENT TRENDS IN PLANT SCIENCES II**	**2.5 Credits (60 lectures)**
Unit I : Ethnobotany and Aesthetic Botany Ethnobotany – Definition, History, Sources of data and methods of study.Aesthetic Botany -Bonsai – Definition, Types, Methods & Tools, Plants. -Ikebana : Types of arrangements -Fresh Flower arrangement in Indian Ceremonies – Rangoli, Garland etc. -Dry Flower arrangement.		**15 Lectures**
Unit II : Plant Geography **Phytogeographical regions of India**. **Biodiversity**: • Definition, diversity of flora found in various forest types of India • Evolution of biodiversity with one example of an evolutionary tree • Levels of biodiversity • Importance and status of biodiversity • Loss of biodiversity • Conservation of biodiversity • Genetic diversity- Molecular characteristics		**15 Lectures**
Unit III : Economic Botany • **Essential Oils:** Extraction, perfumes, perfume oils, oil of rose, sandalwood, patchouli, champaca, grass oils: *Citronella*, vetiver. • **Fatty oils** : Drying oil (linseed and soyabean oil), semidrying oils (cotton seed, sesame oil) and non drying oils (olive oil and peanut oil), • **Vegetable Fats**: Coconut and Palm oil		**15 Lectures**
Unit IV : Post Harvest Technology • **Storage of Plant Produce- Preservation of Fruits and Vegetables** • Drying (Dehydration)- (Natural conditions – Sun drying; Artificial drying- hot air drying, Vacuum drying, Osmotically dried fruits, Crystallized or Candied fruits, Fruit Leather, Freeze Drying), • Freezing (Cold air blast system , Liquid immersion method, Plate freezers, Cryogenic Freezing, Dehydrofreezing, Freeze drying), • Canning • Pickling (in brine, in vinegar, Indian pickles) • Sugar Concentrates (Jams, Jellies, Fruit juices)		**15 Lectures**

• Food Preservatives • Use of Anti-oxidants in preservation.	

SEMESTER VI
PRACTICAL

Semester VI USBOP6		Cr
PRACTICAL PAPER I – PLANT DIVERSITYIII		**1.5**
Bryophyta		
	Study of stages in the life cycle of the following Bryophyta from fresh / preserved material and permanent slides • *Marchantia*	
Pteridophyta		
	Study of stages in the life cycles of the following Pteridophytes from fresh / preserved material and permanent slides • *Equisetum* • *Marselia*	
Biotechnology		
	Growth curve of *E.coli*	
	Plasmid DNA isolation and separation of DNA using AGE	
	DNA sequencing- Sanger's method (give a sequence and let them show how the autoradigram will be)	
	Identification: Restriction mapping, Southern blotting	
	DNA barcoding of plant material by using suitable data	
PRACTICAL PAPER II – PLANT DIVERSITY IV		**1.5**
Gymnosperms		
	Study of stages in the life cycles of the following Gymnosperms from fresh / preserved material and permanent slides • *Gnetum* • *Ephedra*	
Angiosperms		
	Study of one plant from each of the following Angiosperm families • Combretaceae • Rhamnaceae • Asclepiadaceae • Labiatae • Euphorbiaceae • Cannaceae	
	Morphological peculiarities and economic importance of the members of the above mentioned Angiosperm families	
	Identify the genus and species with the help of flora	
Anatomy		
	Study of Ecological Anatomy of • Hydrophytes: *Hydrilla* stem, *Nymphaea* petiole, *Eichhornia* offset • Epiphytes: Orchid • Sciophytes: *Peperomia* leaf • Xerophytes: *Nerium* leaf, *Opuntia* phylloclade • Halophytes: *Avicennia* leaf and pneumatophore, *Sesuvium* leaf • Mesophytes: *Vinca* leaf	
Embryology		
	• Study of various stages of Microsporogenesis, Megasporogenesis and • •	

	• Embryo Development with the help of permanent slides / photomicrographs • *In vivo* growth of pollen tube in *Portulaca*	
PRACTICAL - Paper III –FORM AND FUNCTION III		**1.5**
Plant Physiology and Biochemistry		
	• Determination of alpha-amino nitrogen • Estimation of proteins by Lowry's method • Determination of NR activity in leaf discs	
Genetics		
	• Problems based on three point crosses, construction of chromosome maps • Identification of types of point mutations from given DNA sequences • Study of mitosis using pre-treated root tips of *Allium*	
Bioinformatics		
	• BLAST: nBLAST, pBLAST • Multiple Sequence Alignment • Phylogenetic Analysis • RASMOL / spdbv	
Cosmetology		

	• Estimation of vitamin C from given herb
	• Study of SOD activity of the given plant material
	• Preparation of the following herbal products
	  • Face mask
	  • Bath oil
	  • Hair wash powder	

PRACTICAL - PAPER IV – CURRENT TRENTS IN PLANT SCIENCES IV		**1.5**
Ethnobotany/ Aesthetic Botany		

	• Bonsai (Demonstration)
	• Types of floral arrangements
	  • Flower rangoli
	  • Ikebana
	  • Bouquet
	  • Garland
	  • Dry flower arrangement	

Plant Geography		
	Estimation of the following in the given water sample: • Sulphate • Phosphate • Copper • Lead Calculation of LD_{50} of Phenol / $CuSO_4$ or any heavy metal Forest Products • Timber • Paper • Fibre • Fodder yielding plants	

Economic Botany		
	• Demonstration : Extraction of essential oil using Clevenger • Thin layer chromatography of essential oil of patchouli and *Citronella* • Saponification value of palm oil	
Post-Harvest Technology		
	Preparation of • Squash • Jam • Jelly • Pickle	
		

Scheme of Examinations:

Students offering Double major will study Paper II and III.

Theory Course:

Recommendations for Internal Assessment for	**25 marks**
One periodical test on class instructions	20 marks
Active Participation (attentiveness/ability to answer questions)	05 marks
External Assessment	75 Marks

Practical Course: 50 marks external.

Note:

1. A minimum of four field excursions(with at least one beyond the limits of Mumbai) for habitat studies are compulsory. Field work of not less than eight hours duration is equivalent to one period per week for a batch of fifteen students.
2. A candidate will be allowed to appear for the practical examinations only if he/she submits a certified journal of TYBSc Botany and the Field Report or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of TYBSc Botany as per the minimum requirements. In case of loss of journal a candidate must produce a certificate from the Head of the Department/ Institute that the practical 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.

Reference Books

1. A handbook of Ethnobotany by S.K. Jain, V. Mudgal
2. Plants in folk religion and mythology (Contribution to Ethnobotany by S.K.Jain 3rd Rev. Ed.).
3. Introduction to Plant Physiology by Noggle and Fritz, Prentice Hall Publishers (2002)
4. Plant Physiology by Salisbury and Ross CBS Publishers
5. Plant Physiology by Taiz and ZeigerSinauer Associates Inc.Publishers,2002
6. Genetics by Russel Peter Adison Wesley Longman Inc. (5thedition)
7. An introduction to Genetic analysis Griffith Freeman and Company (2000)
8. Fundamentals of Biostatics by Rastogi,Ane Books Pvt. Ltd. (2009).
9. College Botany Vol I and II by Gangulee Das and Dutta Central Education enterprises.
10. Cryptogamic Botany Vol I and II by G M Smith, Mcg raw Hill
11. Industrial Microbiology by Cassida, New Age International, New Delhi
12. Industrial Microbiology Mac Millan Publications, New Delhi
13. Physiological Plant Anatomy by Haberlandt, Mac Millan and Company
14. Ayurveda Aharby P H Kulkarni
15. Pharmacognosyby Kokate, Purohit and Gokhale,Nirali Publications
16. Bioinformatics by Sunder Rajan
17. Instant Notes on Bioinformatics by Westhead (2002), Taylor Francis Publicati
18. Bioinformatics by Ignasimuthu
19. DNA barcoding plants: taxonomy in a new perspective 2010. K Vijayan and C H Tsou, Current Science, 1530 – 1541.
20. Introduction to Biostatistics by P K Banerjee, Chand Publication.
21. Plant Biotechnology by K. Ramawat
22. Practical Biochemistry by David Plummer, McGraw Hill Publ.
23. Economic Botany by A F Hill, TATA McGRAW-HILL Publishing Co. Ltd.
24. Post-Harvest Technology by Verma and Joshi, Indus Publication
25. Embryology of Plants by Bhojwani and Bhatnagar
26. Pollen Morphology and Plant Taxonomy by G. Erdtman, Hafner PublicCo.,N
27. A text Book of Palynology by K Bhattacharya, New Central Book Agency Pvt. Ltd., London
28. An introduction to Embryology of Angiosperms by P Maheshwari, McGraw Hill Book Co.
29. Plant Systamatics by Gurucharan Singh, Oxford and IBH Publ.
30. Taxonomy of Vascular Plants by Lawrence George, H M, Oxford and IBH Publ.