UNIVERSITY OF MUMBAI
No.UG/140 of 2010

CIRCULAR:-

A reference is invited to the Ordinances, Regulations and syllabus relating to the B.Sc. degree course **vide** Pamphlet **No.** 151 and to this office Circular No.UG/490 of 2003 dated 17th October, 2003 and the Principals of the affiliated Colleges in Science are hereby informed that the recommendation made by the Board of Studies in Botany at its meeting held on 15th December, 2009 has been accepted by the Academic Council at its meeting held on 3rd March, 2010 **vide** item No. 4.34 and that in accordance therewith, the scheme and syllabus of the T.Y.B.Sc. Examination (Theory & Practical) in the subject of Botany is revised as per **Appendix** and the same has been brought into force with effect from the academic year 2010-2011.

MUMBAI-400 032
29th June, 2010

L. R. Mane
Offg. Registrar

To,

The Principals of the affiliated colleges in Science.

A.C./4.34/03/03/2010

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No. UG/140 -A of 2010, MUMBAI-400 032 29th June, 2010

Copy forwarded with compliments for information to :

1) The Dean, Faculty of Science,
2) The Chairperson, Board of Studies in Botany,
3) The Controller of Examination,
4) The Co-ordinator, University Computerization Center.

(D. N. Jadhav)
Ag. Deputy Registrar
UG/PG Section

Copy to:

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistants to the Vice-Chancellar, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative, Ratnagiri for information.

The controller of examinations (10 copies), the Finance and Accounts officer (2 copies), Record Section (5 copies), Publications Section (5 copies), the Deputy Registrar, Enrollment, Eligibility and Migration Section (3 copies), the Deputy Registrar, Statistical, Affiliation Section (2 copies), the Professor-cum-Director, Institute of Distance and Open Learning (IDOL), (10 copies) the Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Deputy Registrar (Special Cell), the Deputy Registrar, (PRO). The Assistant Registrar, Academic Authorities Unit (2 copies) and the Assistant Registrar, Executive Authorities Unit (2 copies). They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and

Enclosure to Item No. 4.34 26/2

UNIVERSITY OF MUMBAI

Revised Scheme & Syllabus

for the

T.Y.B.Sc. Examination
(Theory & Practicals)

in

Botany

(with effect from the academic year 2010 - 2011)

Revised syllabus in Botany

at the T.Y.B.Sc. Examination

(Theory & Practical)

to be implemented from academic year 2010- 2011

PREAMBLE

The revised Botany syllabus for T.Y.B.Sc course to be introduced w.e.f. 2010-2011 is in continuity with the S.Y.B.Sc. Syllabus, revised in academic year 2009-2010. It is revised as per guidelines issued vide University circular AA/ 419 dated 17th October 2007. The entire syllabus is distributed in four papers, each of the paper being further divided in to four units.

The unit wise distribution of the S.Y.B.Sc. syllabus along with the unit wise distribution for T.Y.B.Sc. syllabus is given below.

T.Y.B.Sc. Syllabus introduced W.E.F. 2010-2011

Paper-I: PLANT DIVERSITY-III

Paper-II : PLANT DIVERSITY-IV

Paper-III: Form and Function III

Paper-IV: Current Trends in Plant Sciences-II

Paper	Unit		Paper	Unit	
Paper I	I	Microbiology	Paper III	I	Plant physiology& Bio-chemistry
	II	Algae		Ii	CytoGenetics , Molecular Biology & Biostatistics
	III	Fungi & Plant Pathology		III	Environmental 3otany
	IV	Bryophyta & Pteridophyta,		IV	Plant Geography, Biodiversity and Forestry
Paper II	I	Gymnosperms& Paleobotany	Paper IV	I	plant prc ducts & Entrepreneurship development
	II	Angiosperms		II	Horticulture.
	III	Developmental Botany		III	Pharmacognosy , Medicinal Botany & Cosmatology
	IV	Anatomy		IV	Bio-technology & Bio-informatics

Revised Scheme of Examination & Syllabus in Botany for the T.Y.B.Sc. Course to be brought in to force w.e.f. academic year 2010- 2011.

* Duration of the course :- one year

* Number of theory papers:- Four.

Each paper shall consist of 4 units to be covered in 120 lectures (four periods per week for 30 weeks) = 120 Periods. Each period of 48 minutes duration

* Number of practicals = Four (Practicals I, II, III and IV)

Each practical of 4 periods duration [1 period=48 minutes). One practical .per week.

*Number of students per batch for practical = First batch of 20 students &additional batches of 15 students each.

* Excursions=Four local excursions = 8 Practicals

Scheme of Examination

Theory examination: The year end Examination in each of the four papers will be of 100 marks & of three hours duration.

Each theory paper will comprise of five compulsory questions, with internal options. Each question will be of 20 marks. Total marks for the questions including internal options will be of 30 marks.

Question Paper Pattern:

Q.1. Based on the entire syllabus.

Q.2, 3, 4 and Q.5 based on One unit each

Practical examination:

- Practical examination to be conducted at the end of the year.
- Batch size for the practical examination= 15 students
- Practical- I, II, III & IV = Each of 50 marks of 5 hours duration
- Students shall not be allowed to appear for practical examination without duly certified journal & field report. If the journal or field report is lost the student will be allowed for the practical examination only on submitting a certificate from the head of the department or the principal, but will not get any marks assigned for journal work or field report.

T.Y.B.Sc. Syllabus in Botany to be introduced with effect from 2010 – 2011.

N.B. System of Classification for Algae, Fungi, Bryophyta & Pteridophyta by G. M. Smith.

Paper I --Plant Diversity –III		
Unit I – Microbiology		30
*	Aero microbiology:	
	• Concept, definition, applications and utility in agricultural science, veterinary science, medical science, environmental science and biotechnology	06
	• Aero microbiological techniques:- Principles and methods of air sampling—By using Air samplers and Culture plate techniques	04
	• Microbial components of atmosphere:- Algal, fungal, bacterial, lichen, pollens, Trichomes and animal components (insect parts, hairs, protozoon cysts and mite Material)	07
	• Impact of meteorological parameters on aeromicrobiota.	03
	• Analysis of aeromicrobiota:- Identification, statistical analysis and logical interpretation	04
	• Impact of aeromicrobiota on :- living system – plants, animals and human beings non livings - Biodeterioration, biodegradation of historical monuments, Library, materials, textile material and leather goods.	06
Unit II – Algae		30
*	Systematic position, structure and life cycle of the following	20
	• Cyanophyta: *Rivularia*	
	• Chlorophyta : *Oedogonium, Chara*	
	• Chrysophyta : *Diatoms*	
	• Rhodophyta: *Polysiphonia*	
*	Origin and evolution of sex in Algae	05
*	Habitat diversity in Algae	05
Unit III– Mycology and Plant Pathology		30
*	Systematic position, structure and life cycle of the following	20
	• Phycomycetes- *Albugo*	
	• Ascomycetes yeast, *Xylaria*	
	• Basidiomycetes- *Puccinia*	
	• Deuteromycetes- *Fusarium, Alternaria*	
*	Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures of the following	10
	• Wilt of Pea	
	• Tikka disease of groundnut	
	•Wood rotting fungi – *Ganoderma*	
	•A study of physical, chemical and biological control methods of plant diseases.	

Unit IV – Bryophyta and Pteridophyta		
Bryophyta		30
•	Smith's system of Classification of Bryophyta (upto Order)	16
•	Systematic position, structure and life cycle of the following:	02
	• *Marchantia*	10
	• *Pellia*	
	• *Pogonatum*	
•	Evolution of the sporophyte in Bryophyta	
•	Economic importance of Bryophytes	02
Pteridophyta		02
•	Systematic position, structure and life cycle of the following:	14
	• *Lycopodium*	10
	• *Ophioglossum*	
	• *Marsilea*	
•	Evolution of the sorus in Pterophyta	
	❁❁❁❁❁	04

Paper II --Plant Diversity –IV

Unit I – Gymnosperms and Paleobotany		
Gymnosperms		30
•	Systematic position, structure and life cycle of the following:	15
	• *Thuja*	15
	• *Ephedra*	
	• *Gnetum*	
Paleobotany		
•	Systematic position and structure of the following form genera	15
	• *Lepidodendron*	10
	• *Lyginopteris*	
	• *Pentoxylon*	
•	Fossil records, location/ collection spots	
•	Paleobotanical Institutes – International and Indian	02
•	Contributions of Birbal Sahani to Paleobotany	02
Unit II – Angiosperms		01
•	Characters of Taxonomic Importance	30
	• Anatomy, Palynology and Embryology in relation to Taxonomy	05
•	Historical background of classification	
	• Early Western Civilization	06
	• Era of Herbalists	
	• Natural System of Classification – elaboration on Bentham and Hookers system of Classification	
	• Phylogenetic System of Classification – Engler and Prantl's , Hutchinson's	

Tools of Angiosperm Taxonomy – Library, Floras, Monographs, Dictionary, Periodicals, Index and Journals		04
Systematic Botany- 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:		15
• Capparidaceae	• Sterculiaceae	
• Rutaceae	• Cucurbitaceae	
• Umbelliferae (Apiaceae)	• Asclepiadaceae	
• Scrophulariacea	• Labiatae (Lamiaceae)	
• Amaranthaceae	• Polygonaceae	
• Palmae	• Scitaminae – Sub -family Zingiberaceae	
• Graminae (Poaceae)		
Unit III – Developmental Botany		
Embryology		30
• **Microsporangium**, Structure and development, Microsporogenesis, role of tapetum in microsporogenesis. Development of male gametophyte		17
• **Megasporangium**, Structure and development, megasporogenesis and development of female gametophyte (polygomum type).		08
• **Fertilization**- Double fertilization and its significance		05
•**Development of the embryo** – Dicotyledonous type – *Capsella* type.		02
Palynology		02
• **Pollen and spore morphology**- size and shape, polarity, apertures (NPC), exine stratification, exine excrescences, construction of a palynogram.		13
• **Applications of palynology** in honey industry, coal and oil exploration and forensic science. Aeropalynology and pollen allergy.		06
• **Pollen viability and storage.** Causes for loss of pollen viability, Tests for pollen viability, Pollen storage.		04
• **Germination and growth of the pollen tube**, factors affecting pollen tube growth.		02
Unit IV – Anatomy		01
Types of stomata		30
Anomalous secondary growth in the Stems of *Bignonia, Salvadora, Achyranthes, Aristolochia, Dracaena.* Storage roots of Beet, Radish.		04
Root Stem Transition		10
Ecological Anatomy		04
•Hydrophytes	• Epiphytes	12
• Psyophytes	• Halophytes	
• Xerophytes	• Mesophytes	

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Paper III –Form and Function II

Unit I – Plant Physiology and Biochemistry		
	Translocation of Solutes	30
	Transport of inorganic solutes-Active and Passive Transport, Transport of organic solutes, Shuttle systems, Anatomy of sieve tubes, contents moving through sieve tubes, Mechanism of sieve tube translocation- Munch's Hypothesis,Electro osmosis mechanism and osmotic gradient,Rapid-Slow movement mechanism	05
	Lipid Metabolism	
	Biosynthesis and Degradation of fatty acids and glycerol, Respiratory metabolism in germinating seeds, β-oxidation & energetics of β-oxidation, Types of lipids	08
	Biological Clock	
	Concept of Biological Clock, Time memory system, Practical importance of Biological Clock, Circadian Rhythms- Characteristics, Examples from nature and Significance.	04
	Vegetative Growth	
	General phases of Growth, Growth Curves, Factors affecting growth- External (environmental) and internal (genetic , hormonal, nutritional), Role of plant growth regulating substances- Auxins, Cytokinins and Gibberellins, their commercial applications.	08
	Nitrogen Metabolism	
	Nitrogen Cycle, Root Nodule formation & Leg-haemoglobin, Nitrogenase activity, Assimilation of Nitrates (NR- NiR activity) , Assimilation of Ammonia (Amination & Transamination reactions), Nitrogen Assimilation and Carbohydrate utilization.	05
Unit II – Cytogenetics, Molecular Biology and Biostatistics		
	Mutations –Point Mutations	30
	• Definition	08
	•Types – somatic/ germline, spontaneous/induced, gross/ point - base pair substitutions - transversion, transition; effect of substitution mutation on the phenotype (Missense mutation, Nonsense mutation, Neutral mutations, silent mutation). –frame shift mutations (additions, deletions), –suppression mutation.	
	• Causes of Mutations – DNA replication errors, Induced mutations	
	• Mutagenic agents- physical, chemical (base analogs, base modifying agents)	
	• Role of mutations in plant breeding.	
	Transposable elements	04
	• Transposons, Insertion elements, Mobile genetic elements in Maize (Jumping genes) .	
	Genetic Mapping in *Neurospora*	06
	• Linear Tetrad Analysis	
	Regulation of gene expression in prokaryotes	06
	• **Gene regulation** of lactose utilization in *E coli, lac* operon	
	Biostatistics	06
	• Coefficient of correlation – ANOVA (Ftest)	
Unit III – Environmental Botany		30
	Bioremediation	09
	• Bioremediation: Principles, Factors responsible and Microbial population in bioremediation. • Biomagnification • Bioaccumulation and biotransformation • Phytoremediation: Metals, organic pollutants Composting: Technology, process and factors influencing composting.	

•	**Toxicology**	04
	• Pesticides: use in agriculture and public health programme • Basic principles of toxicology including LD50 and LC50, Absorption, Distribution and physiological effects- Lead and Parathion	
•	**Global Environmental issues.**	09
	Global Environmental problem and remedial measures • Climate change: Global worming and green house effect • Ozone depletion • Acid rain • GMO-Biosafety measures • Consequences of the use of pesticides and fertilizer. • Surface water and industrial pollution: e.g. Ganga river water • Air pollution in metro cities • Waste management including e-waste.	
•	**Citizen Awareness: Ethical and Legal issues:**	08
	• Ethical issues in Biodiversity- IPR, Ethical Aspects • (a) Clinical trials, b) Toxicity testing for assessment of environment agents, c) Toxic waste disposal & trading • Awareness of existing environmental laws and role of citizen groups in environmental management. • Industry: siting criteria and EIA • Industrial Safety: Case study- Bhopal gas tragedy	
Unit IV – Plant Geography, Biodiversity and Forestry		30
•	**Phytogeographical regions of India**	06
•	**Biodiversity**	14
	• Definition • Biodiversity, distribution 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	
•	**Forest Products**	10
	• Major and Minor Forest products • Timber Industry • Paper Industry • Fodder yielding plants.	

Paper IV –Current Trends in Plant Sciences II

Unit I-Plant Products & Entrepreneurship Developement		30
*	Introduction to plant products.	01
*	Cultivation, extraction and making of • Essential oils – Rose, *Critronella* • Dyes - Curcumin	09
*	Entrepreneurship development in above products and preparation of a business plan for the same.	10
*	Mushroom industry – cultivation, picking and packaging, marketing and economics of the business.	10
Unit II – Horticulture		30
•	**Micropropagation**	15
	• Laboratory organization and techniques in plant tissue culture • Totipotency • Organogenesis • Organ culture – root cultures, meristem cultures, anther and pollen culture, embryo culture. • Somatic Embryogenesis and artificial seeds • Protoplast Fusion and Somatic Hybridization • Applications of tissue culture	
•	**Post Harvest Technology – Preservation of Fruits and Vegetables**	15
	• 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) and • Sugar Concentrates(Jams, Jellies, Fruit juices) • Use of chemical Preservatives • Use of Anti-oxidants	
Unit III–Pharmacognosy, Medicinal Botany and Cosmetology		30
•	Cultivation Practices of the following medicinal plants with respect to Soil, Propagation methods, irrigation, manuring (fertilizers), harvesting, processing, storage, pests and Diseases, marketing and their medicinal uses *Allium sativum* *Acorus calamus* *Curcuma longa*	06
•	Monograph of drugs with respect to Biological sources, geographical distribution, common varieties, macro and microscopic characters, chemical constituents, and therapeutic uses, adultrants of the following plants/drugs: *Oscimum basillum* *Strychnos nux-vomica*(seeds)	04

•	• Introduction to herbal cosmetics definition, collection and processing of herbal material, natural and artificial drying of herbal material. • Standardization of raw material – importance of Standardization, physical and chemical methods of standardization, quantitative and qualitative estimation of phytoconstituents • 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.	04 06 08 02
Unit IV – Biotechnology and Bioinformatics		30
•	Biotechnology	20
	• 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 –Sanger's Method, Northern Hybridization)	05 10 05 05
•	Bioinformatics	10
	• Organization of biological data, databases • Exploration of data bases, retrieval of desired data, BLAST etc. • Protein structure analysis and application. • Multiple sequence analysis and phylogenetic analysis.	

T.Y.B.Sc. Syllabus in Botany to be introduced with effect from 2010 – 2011.

N.B. System of Classification for Algae, Fungi, Bryophyta & Pteridophyta by G. M. Smith.

	Paper I --Plant Diversity –III	
Unit I – Microbiology		
*	Aero microbiology:	30
	• Concept, definition, applications and utility in agricultural science, veterinary science, medical science, environmental science and biotechnology	06
	• Aero microbiological techniques:- Principles and methods of air sampling—By using Air samplers and Culture plate techniques	04
	• Microbial components of atmosphere:- Algal, fungal, bacterial, lichen, pollens, Trichomes and animal components (insect parts, hairs, protozoon cysts and mite Material)	07
	• Impact of meteorological parameters on aeromicrobiota.	03
	• Analysis of aeromicrobiota:- Identification, statistical analysis and logical interpretation	04
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	• Chlorophyta : *Oedogonium, Chara*	
	• Chrysc phyta : *Diatoms*	
	• Rhodophyta: *Polysiphonia*	
*	Origin and evolution of sex in Algae	
*	Habitat diversity in Algae	05
Unit III– Mycology and Plant Pathology		05
*	Systematic position, structure and life cycle of the following	30
	• Phycomycetes- *Albugo*	20
	• Ascomycetes- yeast, *Xylaria*	
	• Basidiomycetes- *Puccinia*	
	• Deuteromycetes- *Fusarium, Alternaria*	
*	Study of plant diseases: Causative organism, symptoms, predisposing factors, disease cycle and control measures of the following	10
	• Wilt of Pea	
	• Tikka disease of groundnut	
	•Wood rotting fungi – *Ganoderma*	
	•A study of physical, chemical and biological control methods of plant diseases.	

Practical II --Plant Diversity –IV

Gymnosperms and Paleobotany

- Study of stages in the life cycle of the following from fresh/ preserved material and permanent slides: *Thuja, Ephedra, Gnetum*
- Study of the following form genera with the help of permanent slides/ photomicrographs: *Lepidodendron, Lyginopteris, Pentoxylon*

Angiospermae

- Study of one plant from each of the following families:
  - Capparidaceae
  - Sterculiaceae
  - Rutaceae
  - Cucurbitaceae
  - Umbelliferae
  - Asclepiadaceae
  - Scrophulariacea
  - Labiatae
  - Amaranthaceae
  - Polygonaceae
  - Palmae
  - Zingiberaceae
  - Poaceae

Morphological peculiarities and economic importance of the members of these families.

Developmental Botany

Study of the various stages of Microsporogenesis, Megasporogenesis and Embryo development with the help of permanent slides/ photomicrographs.

- *In vivo* growth of the pollen tube (*Portulaca*)
- Study of Pollen Morphology (NPC analysis) of the following by Chitley's Method *Hibiscus, Datura,* Labiatae, *Crinum, Pancratium, Canna*
- Determination of Pollen viability
- Study of Air-borne pollen with the help of Tilak's Air Sampler
- Pollen analysis from Honey Sample: unifloral and Multifloral Honey

Anatomy

- Study of Absorbing tissue system
- Study of Anomalous secondary growth in the stems of *Bignonia, Salvadora, Achyranthes, Aristolochia, Dracaen* by the Double Staining technique

Study of Anomalous Secondary growth in the Storage Roots of Beet and Radish.

- Study of Ecological Anatomy for
  - Hydrophytes
  - Psyophytes
  - Xerophytes
  - Halophytes
  - Epiphytes
  - Mesophytes

Practical III –Form and Function II

Plant Physiology and Biochemistry

- Determination of alpha- amino nitrogen
- Estimation of Proteins by Lowry's Method
- Colorimetric Estimation of Fatty acids
- Determination of Saponification value of the given oil sample
- Separation of Fatty Acids by TLC
- Determination of NR activity in Leaf Discs
- Quantitative analysis of Amylase in GA treated and non-treated seeds.

Cytogenetics. Molecular Biology and Biostatistics

Identification and consequences of Types of Point Mutations

- Substitution Mutations: missense, nonsense, neutral and silent mutations
- Frame shift Mutations: addition, deletion.

(Genetic Code Dictionary to be provided)

Study of the effect of *p*DB on Mitosis

Study of Mitosis in Shoot tips using shoot tips of *Cestrum* or any suitable material.

Study of smear preparation for stages in Meiosis using any suitable material

Calculation of Chiasma frequency from permanent slides/ photomicrographs.

Jumping Genes in Maize

Tetrad Analysis in *Neurospora* and construction of linkage map in *Neurospora*

Calculatoin of coefficient of correlation

ANOVA (F Test)

Environmental Botany, Plant Geography, Ecology and Forestry

Estimation of the following in/of the given water sample:

- Dissolved oxygen content
- Biological oxygen demand
- Chemical oxygen demand
- Hardness
- Salinity
- Acidity
- Alkalinity
- Sulphate
- Phosphate
- Copper, lead

Calculation of LD50 of Phenol/ $CuSO_4$ or any Heavy metal

Identification of Phyto-geographical regions of India

Forest Products

- Timber
- Paper
- Fibre
- Fodder yielding plants

Practical IV – Current Trends in Plant Sciences

Plant Products and Entrepreneurship Developement

- Identification of plant products based on exomorphic and endomorphic features, and chemical tests for active constituents, -
  Alkaloids – *Vinca, Datura, Adathoda*
  Glycosides- *Aloe, Senna,* Arjuna bark,
  Tannins – banana leaf, *Terminalia belerica/ T. chebula*
- Identification of dye yielding plant products based on exomorphic and endomorphic features and study of the absorption spectrum of the dye,
  Curcuma longa
  Bixa oleracea
  Henna
- Mushroon cultivation (demonstration) – identification of various steps involved (spawn, pin head stage and mature stage).

Horticulture

- Plant Tissue Culture –
  - Various sterilization techniques, preparation of stock solutions, preparation of MS medium.
  - Seed sterilization, callus induction and regeneration.
  - Encapsulation of axillary buds.
- Preparation of
  - Squash
  - Jam
  - Jelly
  - Pickle

Pharmacognosy, Medicinal Botany and Cosmetology

- Chemical testsfor the active constituents of the following plants
  Allium sativum
  Acorus calamus
  Curcuma longa
- Preparation of the following herbal products
  Face mask, Bath oil, shampoo,

Biotechnology and Bioinformatics

DNA Sequencing

- BLAST: nBLAST, pBLAST
- Multiple Sequence Alingment
- Phylogenetic Analysis
- RASMOL / spdbv

Suggested Reference Books

Paper III

Physiology and Plant Biochemistry

- **Noggle & Fritz** *Introduction to Plant Physiology*. Prentice/Hall Publishers
- **Salisburry & Ross** *Plant Physilogy*. Prentice/Hall Publishers
- **Mukherji and Ghosh** *Plant Physiology*.. New Central Book Agency, Calcutta
- **Verma SK and Verma M** *A Textbook of Plant Physiology & Biochemistry & Biotechnology* S Chand Publications
- **Purohit SS** *Plant Growth and Development* .Agrobotanica, New Delhi
- **Shrivastava & Gopalji.** *Hormonal Regulation of Plant Growth and Development* Agrobotanica, New Delhi
- **Wilkins & Malcom** *Physiology of Plant Growth & Development*. Tata MacGrow Hill

Cytology, Molecular Biology and Biostatistics

- Russell Peter. *Genetics* (Fifth edition) Adison Wesley Longman, Inc
- **Griffith, Miller, Suzuki, Lewontin and Gelbart** *An Introduction to Genetic Analysis* (Sixth edition) W H Freeman and Company, New York.
- **Stansfield W. D.** *Schaum's Outline Series – Genetics* (third edition) McGraw Hill International editions
- **Klug, S and Cummings, M. R.** *Concepts of Genetics*_ W. Spencer (Seventh edition). Pearson
- **Panse V.G. and Sukhatme P. V.** *Statistical Methods for Agricultural Workers* ICAR Publication, New Delhi.
- **Mahajan**
- **Rastogi V. B.** *Fundamentals of Biostatistics* (Second Edition) Ane Books Pvt. Ltd. India

Environmental Botany, Plant Geography, Biodiversity and Forestry

1. Gwendolyn Burke, Ben Ramnarine Singh, Louis Theodore, Handbook of Environmental Management and Technology,

- Gary S. Moore, Living with the Earth: Concepts in Environmental Health Science, Lewis Publishers.
- George Tchobanoglous " Metcalf & Eddy's Wastewater Engineering: Treatment and Reuse" McGraw-Hill.
- Peirce, J. Jeffrey , Weiner, Ruth F. and Weiner, Ruth," Environmental Pollution and Control," Butterworth-Heinemann.

- T. Matsuo, K. Hanaki, S. Takizawa, and H. Satoh, "Advances in Water And Wastewater Treatment Technology", Elsevier.
- Daniel Vallero, "Engineering The Risks Of Hazardous Wastes", Elsevier.
- Nicholas P. Cheremisinoff, "Environmental Technologies Handbook",
- S.Purohit Shami And Agrawal "Environmental Sciences:Anew Approach",
- Baird Cann: Environmental Chemistry.
- Status of Indian Environment-Anil Agarwal.
- Down to Earth magazine.
- Environmental survey: Hindu
- Ecology, Evolution and population Biology, reading from Scientific American with Introduction by Edward.O.Wilson, W.h.Freeman and compny, Sanfransico, USA, 1973.

Paper IV

Horticulture

- **Dodds and Roberts** *Plant Tissue Culture* (second Edition)
- **Kalyan Kumar De** *Plant Tissue Culture* (second Edition) New Central Book Agency Calcutta.
- **Ramawat K. G.** *Plant Biotechnology* (second Edition) S Chand and Company, New Delhi

Biotechnology and Bioinformatics

- **Russell P. J.** *Genetics* (Fifth edition) Adison Wesley Longman, Inc
- **Ignacimuthu S.** *Basic Bioinformatics* Narosa Publishing House India.
- **Mount David** *Bioinformatics Sequence and Genome Analysis* (second Edition)