PSG College of Arts & Science

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Since 1947

B.Sc. BOTANY

2016 - 2019

BSc BOTANY
Scheme of Examinations
(For students admitted from 2014-15& onwards)

CODE NO.	SUBJECT	Exam Duration (Hrs)	Max. Marks			Credit points
			CA	CE	Total	
FIRST SEMESTER						
	Part – I					
14LAU01 12LAU01 14LAU01	Tamil – I OR Hindi – I OR French-I	3	25	75	100	3
	Part – II					
14EU01	Communicative English - I- Interpersonal Communication	3	25	75	100	3
	Part – III					
14BOU01	Microbiology	3	25	75	100	3
14BOU02	Plant Diversity	3	25	75	100	3
14BOU03	Zoology I(Allied-ZO)	3	25	75	100	4
	Plant Science Practical I	-	-	-	-	-
	Zoology Practical (Allied-ZO)	-	-	-	-	-
SECOND SEMESTER						
	Part – I					
14LAU02 12LAU02 14LAU02	Tamil – II OR Hindi – II OR French-II	3	25	75	100	3
	Part – II					
14EU02	Communicative English II– Academic Communication	3	25	75	100	3
	Part – III					
14BOU04	Vegetative Plant Biology	3	25	75	100	4
14BOU05	Reproductive Plant Biology	3	25	75	100	4
14BOU06	Zoology II (Allied -ZO)	3	25	75	100	4
14BOU07	Plant Science Practical I	3	40	60	100	4
14BOU08	Zoology Practical(Allied-ZO)	3	40	60	100	2
	Part – IV					
14VEU01	Value Education	--	100	--	100	2

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CODE NO.	SUBJECT	Exam Duration (Hrs)	Max. Marks			Credit points
			CA	CE	Total	
THIRD SEMESTER						
	Part – I					
14LAU03 12LAU03 14LAU03	Tamil – III OR Hindi – III OR French-III	3	25	75	100	3
	Part – II					
14EU03	Communicative English III- English for Career	3	25	75	100	3
	Part – III					
14BOU09	Cell and Tissue Biology	3	25	75	100	4
14BOU10	Biological Data Analysis	3	25	75	100	4
14BOU11	Chemistry I(Allied -CH)	3	25	75	100	4
	Plant Science Practical II	-	-	-	-	*
	Chemistry Practical (Allied -CH)	-	-	-	-	*
	Part – IV					
14ESU01	Environmental Studies	--	100	--	100	2
FOURTH SEMESTER						
	Part – I					
14LAU04 12LAU04 14LAU04	Tamil – IV OR Hindi – IV OR French-IV	3	25	75	100	3
	Part – II					
14EU04	Communicative English- IV English Through Literature and Newspapers	3	25	75	100	3
	Part – III					
14BOU12	Genetics and Genetic Improvement of Crops	3	25	75	100	4
14BOU13	Molecular Biology	3	25	75	100	4
14BOU14	Chemistry II(Allied -CH)	3	25	75	100	4
14BOU15	Plant Science Practical II	3	40	60	100	4
14BOU16	Chemistry Practical (Allied -CH)	3	40	60	100	2
	Part –IV					
14SBU01	**Skill Based Subject** : Internet Security	--	100	--	100	2

Cont …

CODE NO.	SUBJECT	Exam Duration (Hrs)	Max. Marks			Credit points
			CA	CE	Total	
FIFTH SEMESTER						
	Part –III					
14BOU17	Plant Systematics & Economic Botany	3	25	75	100	4
14BOU18	Microbial Biotechnology	3	25	75	100	4
14BOU19	Basics of Bioinformatics	--	100	---	100	4
14BOU20A 14BOU20B	**Core Elective Paper - I** Phytomedicine OR Understanding Biological Database	--	100	---	100	4
	Plant Science Practical III	-	--	-	-	*
	Part –IV					
14NME01	**Non-Major Elective (1) :** EDC	--	100	--	100	2
14NME02	**Non-Major Elective (2) :** General Awareness (On-line Test)	1½	--	100	100	2
SIXTH SEMESTER						
	Part –III					
14BOU21	Plant Ecology	3	25	75	100	4
14BOU22	Genetic Engineering	3	25	75	100	4
14BOU23	Plant Metabolism	3	25	75	100	4
14BOU24	Horticulture & Plantation Crops	3	25	75	100	4
14BOU25A 14BOU25B	**Core Elective Paper – II** Plant Tissue Culture OR Plant Pathology	3	25	75	100	4
14BOU26	Plant Science Practical III	3	40	60	100	4
14BOU27	Plant Science Practical IV	3	40	60	100	4
			Total Credits			**136**

PART-V		**Semesters**	**Credits**
1.	**Extension Activity** :NSS / NCC / Sports / Department Activity	I – VI	2
2.	**Competence Enhancement** **:**Add-on Course / Women's Studies / Extra paper	I – VI	2
		Grand Total	**140**

Students can opt any one EDC of Cluster -III offered by the College at UG level, other than the course offered by their own department.

Allied / Extra Departmental Courses Offered by the Department

Allied :

CODE NO.	SUBJECT	Lecture Hours / week	Exam Duration (hrs)	Max. Marks			Credit points
				CA	CE	Total	
FIRST SEMESTER							
	IDC for B. Sc. Zoology						
14ZOU03	Plant Biology I	4	3	25	75	100	4
	Plant Biology Practical	2	-	-	-	-	*
SECOND SEMESTER							
	IDC for B. Sc. Zoology						
14ZOU06	Plant Biology II	4	3	25	75	100	4
14ZOU08	Plant Biology Practical	2	3	40	60	100	2
FIFTH SEMESTER							
	EDC (CLUSTER EDC)						
14EDCBOU	Horticulture and Mushroom Cultivation (Cluster - III)	2	3	100	-	100	2

FIRST SEMESTER

14BOU01 MICROBIOLOGY 60 hours

Aim: Microbial Structural Diversity, Nutritional Variations, Influence on Environment and usefulness to man.

Unit I

History - Contributions of Louis Pasteur, Robert Koch & Joseph Lister.

Microbial Distribution - Microorganism Distribution in Soil, Water, Air and Extreme Environments.

Virus - General Characteristics, Classification,Transmission. Structure, Multiplication of TMV and T4 phage. Transduction. 12 hours

Unit II

Bacteriology

Bacterial Nutrition - Types of Bacterial Nutrition. Bacterial Population and Growth. Ultra Structural details of a Bacterial Cell. The Cellwall, Capsule, Flagella, Pili, Plasmamembrane, Mesosomes, Nucleic acids, Plasmids, Ribosomes, Pigments, Spores and Cell Inclusions. 12 hours

Unit III

Cyanobacteria - Habit and Habitat. Thallus Variations - Structure of Cyanobacterial cell. Importance to Man and Environment. Structure and Multiplication of *Scytonema* and *Spirulina*.

Lichens - Habit and Habitat. Thallus Organization. Importance to Man and Environment. 12 hours

Unit IV

Mycology

General Characteristics of Fungi. The Three major classes of fungi. Asexual and Sexual Reproduction of *Saccharomyces, Aspergillus,* and *Agaricus.*

Plant pathology

Symptoms of Disease. Causal Organism, Symptoms, Disease Cycle and Control measures of Rust of Wheat, Tikka diseases of Groundnut and Bacterial Blight of Paddy. 12 hours

Unit V

Food Microbiology

General Characteristics of Common Food Spoilage Microbes. Factors Controlling Microbial Spoilage. Food Preservation, Food Borne Infection, Intoxicants and Gastroenteritis, Food Safety and Quality Control. 12 hours

Text Books / Reference Books

1. Desikachary, T.V. (1959). Cyanophyta. ICAR NewDelhi.
2. Frazier, W.C. and D.C. Westhoff (1978). Food Microbiology. Univ. of Wisconsin, Madison, Wisconsin. USA.
3. Dubey, R.C. and D.K. Maheswari (2005). The Text Book of Microbiology. S. Chand and Co. New Delhi.
4. Vashishta, B. R., A. K. Sinha and V. P. Singh. (2008). Botany for Degree Students: Algae. S. Chand & Company Ltd, New Delhi.

5. Sharma. P.D. (2005). Environmental Microbiology.Alpha Science International Ltd. U.K.
6. Sharma .O.P. (2006). A Textbook of Fungi. Tata McGraw Hill Publishing Company Limited. New Delhi.
7. Pelczar J Michael Jr., E.C.S.Chan, Noel R.Krieg (2008). Microbiology. Tata McGraw-Hill Inc., New York.

14BOU02 **PLANT DIVERSITY** **60 hours**

Aim: Learning the Diversity of Life and Variety of Survival and Reproduction.

Unit I

Five Kingdoms Classification Concept.

Algae - Classification of Algae (Fritsch System). General Characteristics, Structure and Reproduction of *Chlamydomonas, Volvox, Oedogonium, Ulva* and *Caulerpa*.

12 hours

Unit II

General Characteristics of Diatoms. Structure and Reproduction of *Dictyota, Sargassum* and *Gracilaria*. Economic importance of Algae. 12 hours

Unit III

Bryophyta - General Characteristics and Classification of Bryophytes. Structure and Reproduction of *Riccia, Porella, Anthoceros* and *Polytrichum*. Ecology of Bryophytes. 12 hours

Unit IV

Pteridophyta -General Characteristics and Classification of Pteridophytes (Sporne). Structure and Reproduction of *Psilotum, Selaginella, Equisetum* and *Adiantum*

12 hours

Unit V

Gymnosperms and Paleobotany - Structure and Reproduction of *Cycas* and *Gnetum*. Geological Era. Fossilization and fossil types – *Lepidodendron* and *Willamsonia.* 12 hours

Text Books / Reference Books

1. Gilbert M. Smith (1955). Crytogamic Botany, Bryophytes and Pteridophytes Vol. II. Mc Graw- Hill Book Company, INC. New York. Toronto, London, Kogakusha Company LTD, Tokyo.
2. Parihar, N. S. (1977). The Biology and Morphology of the Pteridophytes. Central Book Depot, Allahabad.
3. Shukia, A and Mishra S.P (1982). Essential of Paleobotany. Vikas Publishing House Pvt. Ltd.Delhi.
4. Vashishta, B.R. (1979). Botany for Degree Students. Bryophyta. S. Chand & Company LTD. Ram Nagar, New Delhi.
5. Vashista, P.C., A.K. Sinha and Anilkumar (2006). Botany for Degree Students Gymnosperms. S. Chand & Company LTD, Ram Nagar, New Delhi.
6. Vashishta, B.R., A.K. Sinha and V.P. Singh (2005). Botany for Degree Students Algae. S. Chand and Company LTD, Ram Nagar, New Delhi.

14BOU03 **ZOOLOGY – I (50 Hours)** **FIRST SEMESTER**

OBJECTIVES

1. To acquire knowledge of fundamental principles of different phyla
2. To gain thorough knowledge of the diagnostic and adaptive features of Invertebrate animals.

UNIT – I (10 Hours)

1. General characters of Invertebrata and Outline classification up to the level of Phyla with salient features and an example for each Phylum.
2. General characters and Outline classification of Chordata up to the level of and classes with salient features and an example for each class.

UNIT – II (10 Hours)

1. Structure and life-history of:

a) Obelia

b) Taenia solium.

UNIT – III (10 Hours)

1. Morphology, anatomy and life-history of:
   a) Penaeus
2. Morphology and organization of Starfish.

UNIT – IV (10 Hours)

1. Morphology and organ systems of Shark and Frog (excluding endoskeleton).

UNIT – V (10 Hours)

1. Morphology and organ systems of Pigeon and Rabbit (excluding endoskeleton).

REFERENCE BOOKS:

1. Ayyar, E.K. and Ananthakrishnan .T.N, 2007, Outlines of Zoology Vol.I and Vol. II. S.Viswanathan (Printers & Publishers), Pvt Ltd.,Madras.
2. Kotpal,R.L. 2008, Modern Text Book of Zoology Vertebrates, Rastogi Publications, Meerut
3. Nair, N.C. et al., 2008, A Text book of Invertebrates . Saras Publication. Nagercoil
4. Thangamani, A, et al. 2008, A Text book of Chordates. Saras publication. Nagercoil

SECOND SEMESTER

14BOU04 VEGETATIVE PLANT BIOLOGY 60 hours

Aim: Understanding the Structure and function of vegetative parts such as Roots, Stem and leaf of plants towards the fitness to the environment.

Unit I

Root system

Morphology - Types of Roots. The Tap roots, Fibrous roots, Adventitious roots.

Developmental Anatomy - Root tip meristem, Root cap, Zone of elongation, Zone of maturation, Root hairs. Structure of young and mature dicot and monocot plant roots.

12 hours

Unit II

Specialized roots - Breathing roots, Buttress roots, Climbing roots, Prop roots, Floating roots, Velamen and Photosynthetic roots.

Root environment - Rhizosphere, Mycorrhiza, Endo and Ectomycorrhiza and Root nodules.

Physiology of Roots - Absorption of Water, Minerals. Active and Passive Absorption.

Symplastic and Apoplastic passage of water. Guttation and Root Pressure.

12 hours

Unit III

Stem

Morphology - Types of Stem. Erect, Subterranean, Prostrate, Climbing, Herbaceous and Woody Stems

Parts of Stem - Trunk, Internodes, Buds,

Surface - Scars, Spines, Thorns and Lenticels.

Anatomy -Origin of Shoot. Shoot Apical Meristem. Primary and Secondary Anatomy of Dicot and Monocot Stems. Anamalous features in *Achyranthes* and *Nyctanthus* Stem. 12 hours.

Unit IV

Growth of Plant- Process of Secondary Growth in Stem.

Physiology - Conduction of water and nutritive elements in stem. Capillary action, cohesion theory and modern ideas. Pruning, Healing and Root induction in stem cuttings.

Wood - Economic uses of wood. Physical Properties of wood: Hard wood and Softwood. Specific gravity of wood, Warping, Quarter saw and Plain saw wood. Common timbers available in the market and the prices. Chemical Properties- Cellulose, Hemicellulose, Lignin, Resins, Gums, Tannins, Oils and Dyes.

12 hours

Unit V

Leaf

Morphology-Simple and Compound Leaves. Phyllotaxy, Venation, Vernation, Margins, Shapes, Petioles, Leaf Scales and Stipules.

Leaf modifications - Tendrils, Thorns, Pitchers, Phyllodes.

Anatomy - Anatomy of Dicot and Monocot Leaves.

Physiology - Foliar Absorption and Transpiration. Stomata. Functioning of Stomata. Adaptations in leaves towards drought, Moisture, Snow, Predators and Pests.

12 hours

Text Books / Reference Books

1. Gangulee, Das and Datta (1986). College Botany Vol. I. & II New Central Book Agengy, Calcutta.
2. Narayansamy, R. V., K. N. Rao and Raman, A. (1992). Outlines of Botany. S. Viswanathan PVT. LTD. Madras.
3. Vashista, P. C. (1986) Plant Anatomy. Pradeep Publications, Jalandhur.
4. Gupta, S.K. Gupta (1991). Introductory Botany. Kedar Nath Ram, Meerut, Delhi.

14BOU05 REPRODUCTIVE PLANT BIOLOGY 60 hours

Aim: The Morphological, Anatomical, Embryological and Physiological Characteristics of Reproductive Parts of the Plant.

Unit I

Flowers

Parts of flower- Bracts, Bracteoles, Pedicels, Petals, Sepals, Stamens and Pistils.

Inflorescence - Types of Inflorescence.

Pollination - Different types of Pollination. Contrivances in flowers for effective pollination

12 hours

Unit II

Physiology of flowering

Photoperiodism – Photo induction of flowering. Role of phytochrome in flowering and other Plant functions. Biochemical Composition of Phytochromes, Differences between Pr and Pfr forms. Biological clock or circadian rhythms in plants.

12 hours

Unit III

Anther - Structure of Anther - Microsporogenesis. Structure and Development of male gametophyte. Abnormalities in pollen germination (Pollen germination in Cyperaceae, Nemec phenomenon and Anther culture).

Pollen -Pollen Morphology, Viability and Germination of Pollen. Stigma - Pollen Compatibility.

Ovules - Structure of Ovules. Structure of Megagametophytes (Polygonum type)

12 hours

Unit IV

Embryo -Process of Fertilization and Post Fertilization Changes. Development of embryo in a Monocot and Dicot Plant.

Endosperm -Different types (Cellular, Nuclear, Helobial and Ruminate Endosperm). Development of Endosperm and Endosperm Haustoria.

12 hours

Unit V

Fruits - Structure and Classification of Fruits. Simple, Compound, Fleshy and Dry Fruits. Development of Fruits. Physiological Basis for Ripening of Fruits.

Seeds - Structure and Types of Seeds. Types of Germination. Physiology of Seed Germination. Dormancy. Methods to Break Dormancy.

12 hours

Text Books / Reference Books

1. Bhojwani, S.S. & B.P. Bhatnagar (1993). The Embryology of Angiosperms. Vikas Publishing House PVT LTD. New Delhi.
2. Muneeswaran, A. (1990). Embryology of Angiosperms. Rastogi & Co., Meerut, India.
3. Gangulee, Das and Datta (1986) College Botany Vol. I. & II New Central Book Agengy, Calcutta.
4. Narayansamy, R. V., K. N. Rao and Raman, A. (1992) Outlines of Botany.S. Viswanathan PVT. LTD. Madras.
5. Verma P (2006).Plant Physiology, Emkay Publications .New Delhi.
6. Gill.P.S. (2000). Plant Physiology.S.Chand & Co. New Delhi.

14BOU06 **ZOOLOGY – II (50 Hours)**

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OBJECTIVES

1. To acquire knowledge of Agricultural pests
2. To gain knowledge of the silkworm rearing techniques

UNIT – I (10 Hours)

1. General characters of class Insecta.
2. Classification of class Insecta up to the level of orders with salient features and an example for each order.

UNIT – II (10 Hours)

1. Morphology, life-history, destruction caused and control measures of:
   a) Rice Pests: *Tryporyza incertulas, Orseolia oryzae.*
   b) Sugarcane Pests: *Chilo infuscatellus, Chilo sacchariphagus.*
   c) Cotton Pests: *Earias sp. , Pectinophora gossypiella.*

UNIT – III (10 Hours)

1. Methods of pest management.
2. Pesticides and their classification
3. Pesticide application methods.

UNIT – IV (10 Hours)

1. Morphology of mulberry plant
2. A brief account of mulberry varieties
3. Propagation of mulberry
4. Pests and diseases of mulberry: Powdery Mildew, Tukra, Leaf webber

UNIT – V (10 Hours)

1. Silkworm species.
2. Morphology and life-cycle of *Bombyx mori.*
3. Silkworm rearing methods and appliances.
4. Diseases of silkworm: Pebrine, Flacherie, Grasserie.

REFERENCE BOOKS:

1. Madan Mohan Rao, 2007 A Text Book of Sericulture. B.S. Publications Hyderabad.
2. Vasantharaj David, B. and Kumaraswami. T.1982, Elements of Economic Entomology, Popular Book Depot, Madras.
3. Kotpal,R.L. 2007, Modern Text Book of Zoology Invertebrates., Rastogi Publications, Meerut.

14BOU07 PLANT SCIENCE PRACTICAL I

1. Calibration of Microscope.
2. Preparation of Potato Dextrose Agar Medium.
3. Preparation of Nutrient Broth.
4. Isolation of Soil or Litter Fungi.
5. Observation of Scytonema, Nostoc, Spirulina and Lichens
6. Observation of fungi. Mycelium and Reproductive Structure of *Aspergillus, Saccharomyces* and *Agaricus.*
7. Symptoms of Puccinia, Tikka Diseases and Blight of Paddy.
8. Microscopic Observation of Vegetative and Reproductive Structures of *Chlamydomonas, Volvox, Oedogonium* and *Gracilaria*.
9. Morphology and Anatomical Studies of *Ulva, Caulerpa, Dictyota* and *Sargassum*.
10. Observations of Vegetative and Reproductive Structures of *Riccia, Porella, Anthoceros* and *Polytrichum.*
11. Morphological and Anatomical Studies of *Psilotum, Selaginella, Equisetum, Adiantum, Cycas* and *Gnetum.*
12. Observation of Fossilized Specimens – *Williamsonia* and *Lepidodendron*
13. Study of Different Types of Inflorescence.
14. L.S. of Flower to Study Different Floral Parts.
15. Observation of Different Types of Fruits.
16. T.S. of Anther of *Datur*a and *Cassi*a, Pollen Viability Test. *Invitro* Pollen Germination studies using different nutrient media (Hanging Drop Method. *Vinca, Datura, Cassia* or any other suitable material).
17. Structure of Ovule and Embryosac. (Serial Hand Sections and Observing Permanent slides). Examining different types of Endosperm (Permanent Slides).
18. Embryo Dissection - *Tridax procumbens*. Globular, Cardate and Torpedo Stages of Embryo.
19. L.S. of Seeds - Pulses and Cereals. Observation of Internal Parts.
20. Observing seed germination and early seedling growth using Roll Towel Method.

14BOU08 ZOOLOGY (Allied) PRACTICAL

FIRST & SECOND SEMESTER

1. Identification, classification and comments on:

   Paramecium – Entire, *Obelia colony, Obelia medusa.*

   Taenia solium- Entire, Scolex, Cysticercus larva(bladder worm
2. Identification, classification and comments on:

   Penaeus- Entire, Nauplius larva, Protozoea larva, Zoea larva, Mysis larva.
3. Identification, classification and comments on:

   Starfish, Shark, Pigeon and Rabbit
4. Mounting of mouth parts of cockroach.
5. Dissection of digestive system of cockroach
6. Dissection of nervous system of cockroach
7. Dissection of reproductive system of cockroach
8. Mounting of scale of a fish
9. Dissection of digestive system of a marketable fish – Demonstration only
10. Observation of morphology of mulberry plant.
11. Identification and study of mulberry varieties : MR-2, Kanva-2 , Palladam local, S36, S54 and V1
12. Study of morphology and life -cycle of *Bomby mori*.
13. Study of rearing appliances of silk-worm.
14. Determination of shell ratio percentage.
15. Determination of Denier size and Renditta.

THIRD SEMESTER

14BOU09 CELL AND TISSUE BIOLOGY 45 hours

Aim: To Understand the Structural and Functional Elements of Plant Cells and Tissues that contribute to the Survival advantages of Plant Body.

Unit I

Plant Cell - Cell as a Complete Functional Unit of Living System. Diffusion, Osmosis, Imbibition and Plasmolysis.
Cell Wall - Gross structure - Microfibrils, Middle Lamella, and Secondary Wall. Chemical Nature - Cellulose, Hemicellulose, Pectins and Lignins.
Synthesis of Cell Wall. Functions of Cell Wall. 9 hours

Unit II

Plasma Membrane - Biochemical Composition of Membrane. Models of Plasma Membrane - PLP Models and Fluid Mosaic Model.
Mitochondria - The Ultra Structure, Functional Autonomy and Biogenesis of Mitochondria.
Chloroplast -Various types of Plastids. Ultra Structure and Functional Autonomy of Chloroplast. 9 hours

Unit III

Endoplasmic Reticulum - Ultra Structure and Function of Endoplasmic Reticulum.
Golgi Complex - Structural Variations in Golgi Bodies. Ultra Structure and Functions of Golgi Complex. Ribosomes, Microtubules and Vacuoles. 9 hours

Unit IV

Nucleus - Occurrence, Position, Size and Ultra Structure of the Nuclei.
Structure and Functions of Nucleoplasm, Nuclear Membrane and Nuclear Pore complex and Nucleolus. 9 hours

Unit V

Tissue Biology -Differentiation, Maturation and Specialization of Cells into tissues. The Structure, Function and Locations of Parenchyma, Collenchyma, Fibers, Sclerids, Xylem, Phloem and Cambium. 9 hours

Text Books / Reference Books

1. Powar, C.P. (1977). Cell Biology. Himalaya Publishing House, Nagpur.
2. Verma, P.S. and V. K. Agarwal (Reprint 2008). Cytology. S.Chand & Co. New Delhi.
3. Pandey, B.P. (1993). Plant Anatomy. S. Chand & Co. New Delhi.
4. Berry, A. K. (1998). A Text Book of Cell Biology. Emkay Publications, New Delhi.
5. Vashista, P.C. (1986). Plant Anatomy. Pradeep Publications, Jalandhar.

14BOU10 BIOLOGICAL DATA ANALYSIS 45hours

Aim : The aim of the course is to introduce statistical concepts and methods with emphasis on applications in Plant sciences

UNIT I

Biostatistics Definition – Role of Statistics in Bioscience. Quantitative and Qualitative data. Samples and Sampling Methods. 9 hours

UNIT II

Collection of data - Primary Data, Classification of Data- Tabulation and Graphic Representation of data. 9 hours

UNIT III

Measures of Central Tendency – Mean, Median, Mode, Geometric Mean – Merits and Demerits. Measures of dispersion – Range, Standard deviation, Mean deviation, Quartile deviation, Merits and demerits and coefficient of variations. 9 hours

UNIT IV

Standard error – Test of significance (Student T – Test) – Chi - square test, Correlation – Types and methods of correlation and Rank Correlation, 9 hours

UNIT V

Regression, Simple regression equation, Fitting, Prediction, Vital Statistics – measures of vital statistics. 9 hours

Textbooks /Reference Books

1. Prasad.S (2005). Elements of Biostatistics.Rastogi, New Delhi.

14BOU11 **Chemistry I (50 Hours)** **(Allied)**

Objectives

- To develop a foundation in the concepts and facts in all areas of chemistry
- To gain basic knowledge in the fields of drugs, dyes and environmental chemistry

UNIT I

Inorganic Chemistry **(10 Hrs)**

Atomic structure – orbit, orbital – definition, different types of orbitals (s, p, d and f) – shapes of s, p, d and f orbitals. Aufbauf principle, Hund's rule, Pauli exclusion principle. Shapes of molecules – VSEPR theory. Shapes of simple molecules BF_3, PCl_5, SF_6, IF_6 and IF_7. Oxidation and reduction (electronic concept)– oxidation number – definition and calculation of oxidation number. Oxidizing and reducing agents – definition and examples.

UNIT II

Organic Chemistry **(10 Hrs)**

Aromatic compounds – Huckels rule - statement and examples. Benzene – preparation, properties(mechanism not required) and uses.

Alkaloids – definition, classification, preparation, properties and uses of piperine, nicotine and coniine.

Terpenoids – classification – isoprene rule – isolation and uses of geraniol, citral, menthol and camphor.

Natural polymers – starch, cellulose and cellulose derivatives – structure and application.

UNIT III

Drugs and Dyes **(10 Hrs)**

Chemotherapy – analgesics – antipyretics – antibiotics – tranquilizers - sulpha drugs – anesthetics – antiseptics – disinfectants – definition and examples(Two) and uses.

Dyes – definition – examples - requisites of dyes- chromophore, auxochrome –chromogen. Classification (on the basis of application and chemical structure) – Plant based dyes- indigo and alizarin.

UNIT IV

Physical Chemistry **(10 Hrs)**

Kinetics – order, molecularity – Derivation of rate constant for first order reaction - examples - pseudo uni molecular reaction. Complex reactions - consecutive reactions, parallel reactions, reversible reactions and chain reactions – definitions and examples.

Catalysis – types of catalysis –Characteristics of catalytic reactions – Promoters – Catalytic poisoning – Auto catalysis – Negative catalysis – Enzyme catalysis – Mechanism of enzyme catalysis – Characteristics of enzyme catalysis.

UNIT V

Environmental Chemistry **(10 Hrs)**

Environmental pollution - introduction, pollutant, classification of pollutants - types of pollution. Air pollution – définition and sources – effects of acid rain, global warming. Water pollution – definition, classification of water pollution- definition of DO, BOD and COD – effects of Eutrophication Water treatment – primary, secondary and tertiary. Soil pollution - definition –sources of soil pollution – Factors affecting soil pollution– effects of pesticides. Contamination of foods with toxic chemicals, pesticides and insecticides.

Reference Books

1. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shoban Lal Nagi.n Chand and Company, Jalandhar, 27th Edition, 1986.
2. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice Hall of India Private Limited, New Delhi, 6th Edition, 2004 .
3. Text book of Inorganic Chemistry, P.L.Soni, Sultan Chand and Sons, New Delhi, 13th Edition, 1981.
4. Environmental Chemistry, A.K.De, Wiley Eastern LT, New Age international Lt., New Delhi, 3rd Edition, 1995.

FOURTH SEMESTER

14BOU12 GENETICS AND GENETIC IMPROVEMENT OF CROPS

45 hours

Aim: To Understand the Mechanism of Inheritance in Plants and the Role of Genetics in Breeding Crops.

Unit I

Mendel's Experiment - Monohybrid and Dihybrid Experiments. Laws of Inheritance and their exceptions. Incomplete Dominance. Alleles, Iso alleles.

Interactions of Genes - Epistasis, Duplicate Genes, Complementary Genes, Supplementary Genes. 9hours

Unit II

Linkage and Crossing over, Tetrad analysis, Multiple Alleles, Multiple Factor Hypothesis.

Polyploidy. - Types and Significance. 9 hours

Unit III

Mutations - Chromosomal Mutations - Deletion, Duplication, Translocation and Inversion. Gene Mutation - Factors that induce mutations. Mutagens, Type of gene mutations. Importance of Gene Mutations.

Cytoplasmic Inheritance - Inheritance of Plastids. Male Sterility in Maize. Difference between Chromosomal and Cytoplasmic Inheritance. 9 hours

Unit IV

Plant Breeding -Objectives of Plant Breeding - Plant Introduction. Acclimatization. Plant Selection - Mass Selection, Pureline Selection, Clonal Selection, Hybridization and Selection. Breeding for Disease Resistance. Hybrid Vigor and its Importance. 9 hours

Unit V

Genetic Improvement of Crops - Paddy, Wheat, Cotton and Sugarcane. 9 hours

Text Books / Reference Books

1. Dyansagar, V.R. (1986).Cytology and Genetics, Tata McGraw Hill, New Delhi.
2. Shukla, RS and P.S. Chandel (2004).Cytogenetics, Evolution and Plant Breeding. S. Chand & Company, New Delhi.
3. Veer Bala (1991). A Text Book of Genetics. Rastogi, Kedar Nath Ram Nath, Meerut.
4. Sandhyamitra (1996). Genetics a Blue Print of Life Tata Mc graw Hill Publishing company LTD. New Delhi.

14BOU13 MOLECULAR BIOLOGY 45 hours

Aim: To understand the Chemistry, Three-Dimensional Structures and Functions of Biomolecules.

Unit I

Molecules of life - Proteins - Classification of Proteins: Simple, Conjugated and Derived. Chemical Composition of Proteins, Biological Role of Proteins: Structural, Hormonal, Enzymatic, Protective, Contractile, Storage and Toxic Proteins. Primary, Secondary, Tertiary and Quaternary Structures of proteins. 9 hours

Unit II

Molecules of Life - Nucleic acids - Chemical Composition of Nucleic Acids. Structure of DNA (Antiparallel and Complementary). Proof of DNA as Genetic Material. Functions of DNA (Passing on Hereditary Information and Freedom for Variations).

Structure of RNA - Types of RNA - mRNA, tRNA and rRNA.

Functions of RNA - Messenger, Carrier, Structural. 9 hours

Unit III

Replication of DNA - Early proof for semi conservative replication (Stahl's experiment) Process of replication - unwinding, RNA Priming, DNA Polymerase Reactions, Repair Mechanisms.

Types of Replications -Structure of Gene- Prokaryotic Gene Structure, Eukaryotic Gene Structure. Promoter, Enhancer Element, Upstream Element, TATA box, Coding Regions, Exons, Introns and Transcription Initiation Regions. 9 hours

Unit IV

Protein synthesis - Genetic code - Degeneracy of Codes, Universality, Non overlapping nature, Transcription - Synthesis of mRNA and Post Transcriptional changes.

Translation - Binding of mRNA to Ribosomes, Aminoacid activation. Initiation of polypeptide, Chain elongation, Chain termination and fate of mRNA. 9 hours

Unit V

Gene regulation - Gene Regulation in Prokaryotes. Repression and Induction, Positive and negative Regulations. Gene Regulation in Eukaryotes.

Organization of Chromosome - Chromosome organization. Ultra Structure, Morphology and Karyotypes. Special types of Chromosomes. Giant types, Lamp brush and B- Chromosomes. 9 hours

Text Books / Reference Books

1. Jain, J.L. (1992). Fundamentals of Biochemistry. S.Chand and Co. New Delhi.
2. Arumugam, N. (2001). Cell Biology. Saras Publication. Nagercoil.
3. Powar, CB. (1981) Cell Biology, Himalaya Publications. Nagpur.
4. Gupta, P.K. (1987). Genetics. Rastogi Publicatioins, Meerut.
5. Sandhyamitra (1996) Genetics a Blue Print of Life Tata Mc graw Hill Publishing Company LTD. New Delhi.

14BOU14 **Chemistry II (50 Hours)** **(Allied)**

Objectives

- To develop a foundation in the concept and facts in all areas of chemistry
- To be familiar with the fundamental reactions involved in chemistry
- To create awareness for safe handling of chemicals and laboratory hygiene

UNIT I

Inorganic Chemistry **(10 Hrs)**

Sulphur compounds – sodium hydrosuphite- preparation properties and uses. Peracids of sulphur – permono sulphuric acid and perdi sulphuric acid – preparation properties and uses. Sulphur compounds as preservatives – sodium metabisulphite. Coordination compounds – definition of coordination compounds – Werner's coordination theory- nomenclature. Chelation and its industrial importance. EDTA and its applications. Biological role of haemoglobin and chlorophyll. Fertilizers – definition, classification of fertilizers, need of fertilizers. Nitrogenous fertilizers–urea. Phosphatic fertilizers – triple superphosphate.

UNIT II

Organic Chemistry **(10 Hrs)**

Heterocyclic compounds – definition and classification – chemistry of furan, thiophene, pyridine (preparation, properties and uses). Amino acids – definition, classification – glycine, alanine – preparation properties and uses. Proteins – definition, classification – primary, secondary and tertiary structure of proteins.

Enzymes – characteristics and mechanism of enzyme action, coenzyme. Manufacture of spirit, wine and vinegar. Ethyl alcohol from molasses.

UNIT III **(10 Hrs)**

Purification and separation techniques

Concentration Terms -Mass percentage, volume percentage, normality, molarity, molality, mole fraction, and ppm.

Extraction of organic compounds- methods of purification of solids- crystallization, fractional crystallization, sublimation methods of purification of liquids- Distillation, fractional distillation, steam distillation, distillation under reduced pressure, counter current distribution.

Chromatography- types, paper, column, Thin layer, ion-exchange chromatography principle and application.

UNIT IV

Physical Chemistry **(10 Hrs)**

Faraday's law and Ohm's law - conductance – specific conductance, molar conductance and equivalent conductance definitions. Relationship between specific conductance and equivalent conductance. Effect of dilution on conductance. Measurement of conductance of the solution-cell constant, definition and determination. Kohlrasch law, Oswald's law. p^H and buffer solutions – definition, mechanisms of buffer action, importance of pH and buffers in the living system.

Adsorption-Types of adsorption, adsorption of gases by solids. Adsorption isotherms – Freundlich, Langmuir. Adsorption of solutes from solutions. Application of adsorption.

UNIT V

Environmental Chemistry **(10 Hrs)**

Chemistry of hemoglobin, myoglobin, transport of oxygen transport and storage, non heme iron sulphur proteins, role of essential and trace elements in biological systems.

Heavy metals – industrial uses and pollution sources. Toxicity of mercury, cadmium, lead, chromium and zinc. Fluoride toxicity.

Green chemistry – an elementary idea, green synthesis (any two example).

Reference Books

1. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shoban Lal Nagin Chand and Company, Jalandhar, 27th Edition, 1986.
2. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice Hall of India Private Limited, New Delhi, 6th Edition, 2004 .
3. Text book of Inorganic Chemistry, P.L.Soni, Sultan Chand and Sons, New Delhi, 13th Edition, 1981
4. Environmental Chemistry, A.K.De, Wiley Eastern LT, New Age international Lt., New Delhi, 3rd Edition, 1995

14BOU15 PLANT SCIENCE PRACTICAL II

1. Colorimetry
2. Centrifugation
3. P^H meter
4. Preparation of Buffer
5. Chromatography – Paper
6. Chromatography – Thin Layer
7. Leaf Area Meter
8. Dry Weight Measurement
9. Cytometry
10. Spectrophotometry
11. Concentration and Rotary Evaporator
12. Soxhelet Extraction
13. Problems (Genetics) in Interaction of Genes.
14. Visit to Plant Breeding Research Stations.
15. Cell structure and arrangement of Onion skin. Staining and mounting procedure for microscopy.
16. Comparing the cell shapes of Onion peel, *Hydrilla*, and *Spirogyra*.
17. Interpreting electron micrographs of eukaryotic cell organelles.
18. Observing Mitotic Divisions - Squash of Onion root tips
19. Study of Meiotic Divisions - Smear of *Tradescantia* pollen mother cells.
20. Study of different tissues such as parenchyma, collenchyma, sclerenchyma and fibers using free hand sectioning and maceration.
21. Maceration of wood to observe the vascular tissues.
22. Experiments to measure the osmotic pressure of *Rhoeo discolor* leaf epidermal cells by plasmolytic method.
23. Experiment to measure the DPD of potato tubers by gravimetric method.
24. Determination of membrane permeability under different experimental conditions.
25. Rate of transpiration as affected by various experimental conditions.
26. Problems in Biostatistics - Mean, Median and Mode Standard Deviation and Standard Error.

14BOU16 Chemistry Practical (50 Hours) Semesters-I&II

UNIT I

Acidimetry and Alkalimetry (9 Hrs)

1. Estimation of sodium hydroxide
2. Estimation of sodium carbonate
3. Estimation of hardness of water

UNIT II

Permanganometry (9 Hrs)

4. Estimation of ferrous sulphate
5. Estimation of ferrous ammonium sulphate
6. Estimation of oxalic acid

UNIT III

Dichrometry (8 Hrs)

7. Estimation of ferrous iron using internal indicator
8. Estimation of ferrous iron using external indicator

UNIT IV

Organic Analysis (12 Hrs)

Analysis of organic compounds to detect

(i) Special elements present/absent (ii) Aromatic/ aliphatic (iii) Saturated / unsaturated

UNIT V

Detection of Functional Groups by Confirmatory Tests (12 Hrs)

Glucose, benzoic acid, cinnamic acid, succinic acid, benzaldehyde, acetophenone, benzamide, urea, aniline and phenol.

Reference Books

1. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy and A.R. Kulandaivelu,
2. Practical chemistry, A.O. Thomas, Scientific Book Centre, Cannanore –I, 7th edition 1999.

FIFTH SEMESTER

14BOU17 PLANT SYSTEMATICS & ECONOMIC BOTANY 65 hours

Aim: To impart the Knowledge of Principles of Angiosperm Classification and Diversification of life forms. Familiarizing the Binomials, Habits and Habitats of Plants through the field trip and Preparation of Herbarium.

Unit I

Systems of Classification - Aims of Classification. Specimen Identification through Dichotomous Key. Natural System of Classification (Bentham and Hooker). Phylogenetic System (Engler and Prantl).Modern trends in Taxonomy. Numerical Taxonomy. International Code of Botanical Nomenclature. Typification, Priority, Author Citation. Effective and Valid Publications. Herbarium Techniques. 15 hours

Unit II

Polypetalous Families - Annonaceae. Brassicaceae, Rutaceae, Leguminosae, Cucurbitaceae and Apiaceae. 10 hours

Unit III

Gamopetalous Families - Asteraceae, Asclepiadaceae, Apocyanaceae, Acanthaceae, Verbenaceae and Lamiaceae. 10 hours

Unit IV

Monochlamydous Families - Amarantaceae and Euphorbiaceae

Monocotyledonous Families - Orchidaceae, Cannaceae, Liliaceae, Arecaceae, and Poaceae. 15 hours

Unit V

Economic Botany - Binomials, Common names, Parts of the Plant Used, Cultivation, Harvest and Processing of Cereals (Wheat and Paddy), Pulses (Red Gram and Chick Pea), Fibers (Cotton and Jute), Spices (Coriandrum and Clove). 15 hours

Text Books / Reference books

1. Gamble J.S. and C.E.C. Fischer **(**1915-38) Flora of Presidency of Madras**.** Vol**.** 1-3**.** BSI**,** Calcutta**.**
2. Anonymous**,** (1972). The Wealth of India: Raw Materials. IX. Publications and Information Directorate, C.S.I.R., New Delhi.
3. Singh V. and D.K Jain (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
4. Matthew, K. M. (1983). The Flora of the Tamilnadu Carnatic. Published in Rapinat Herbarium, St. Joseph's College (Tiruchirapalli, India).
5. Sharma, P. D. (1986). Text Book of Taxonomy -. Tata McGraw Hills, New Delhi.
6. Sundararajan, S. (1999). Morphology and Economic Botany of Angiosperms. Vedams eBooks (P) Ltd. Pitampura, New Delhi.
7. Sambamurthy.A.V.S.S. (2005) Taxonomy of Angiosperms.I.K.International Pvt.Ltd.New Delhi.

14BOU18 MICROBIAL BIOTECHNOLOGY 65 hours

Aim: Study of Culture Media, Equipment, Organisms Involved and Down stream Processing of Biotechnology.

Unit. I

Industrial Biotechnology- History of Development, Screening Techniques - Primary Screening, Secondary Screening, Strain Development, Preservation of microorganisms, Preparation of inoculums, Centers of Type Collection. 10 hours

Unit II

Fermentors - General Design Considerations, Fermentor Configurations -The Batch Fermentor, The Continuous Stirred Tank Fermentor, The Tubular Fermentor and Solid State Fermentation. Raw Materials for Fermentation, Sterilization of Media and Fermentors. 10 hours

Unit III

Biotechnology Products: Organic Acids, Solvents and Antibiotics -Lactic acid Production, Citric Acid Production, Alcohol and Wine Production. Production of Antibiotics - Brief History, Penicillin, Streptomycin and Tetracycline. 15 hours

Unit IV

Biomass and Energy -Microbial Proteins - Economics and Advantages. Organism involved, Production Technology – Bacteria, Fungi, Algae ,Yeast and Yeast products. Sewage and Sewage Disposal. Biogas Production. Mushroom Cultivation. 15 hours

Unit V

Enzymes and Vitamins and Insecticides -Production of Proteases, Cellulases, Amylases, Vitamins, Microbial Insecticides - Bacterial and Fungal Production. 15 hours

Text Books / Reference books

1. A. H. Patel (1985). Industrial Microbiology, McMillan (India) Ltd., Bombay
2. Casida, C. (1964) Industrial Microbiology. Wiley Eastern Ltd. New Delhi.
3. Prescott and Dun (1983). Industrial Microbiology. McGraw-Hill Book Co., New York, Toronto.

14BOU19 **BASICS OF BIOINFORMATICS** **60 hours**

Aim: To Understand the Basics of Biological Database, Sequence Analysis and Drug Designing.

Unit I

Bioinformatics - Definition, History, Scope and Applications. Opportunities in Bioinformatics.

Database - The Relational Databases, Querying the Database, Data Warehousing and Data Mining. 12 hours

Unit II:

GENBANK, EMBL, DDBJ, NBRF-PIR, SWISSPROT, Protein Data Bank (PDB), **Protein Structure Classification Databases** - SCOP and CATH, Genome Data Bank, Metabolic Pathway Data Banks, KEGG Analytical tools for Sequences Databases - BLAST, FASTA and 3D structure viewers (Rasmol, SPDBv, PyMol). 12 hours

Unit III:

Genomics - Genome Sequencing, Genome Assembly, Structural, Comparative and Functional Genomics. Microarray Techniques.

Cheminformatics - PUBCHEM. Cheminformatics Tools for Drug Discovery. **Proteomics** - Secondary Structure Prediction and Homology Modeling. 12 hours

Unit IV:

Sequence Analysis - Global and Local Alignment, Scoring Matrices- PAM and BLOSUM, Dot Matrix, Dynamic Programming. 12 hours

Unit V:

Drug Discovery - Introduction, Structure Based Drug Design, Ligand Based Drug Design, Target Identification and Validation, Structure-Activity relationship. Pharmacokinetics and Pharmacodynamics. 12 hours

Text Books / Reference Books :

1 K.Mani and Vijayaraj. (2002) Bioinformatics for Beginners.
2 Arthur M.Lesk. (2002). Introduction to Bioinformatics.
3 S.SundaraRajan and R.Balaji. (2002).Introduction to Bioinformatics.
4 David W. Mount. (2001). Bioinformatics: Sequence and Genome Analysis.
5 Prakash S.Lohar (2009).Bioiformatics, MJP Publishers.

PRACTICALS

1. Retrieving Databases.
2. Retrieving articles from PubMed.
3. Retrieving structural data of a protein using PDB Database.
4. Retrieving Gene and genome Information from TAIR Database.
5. Designing a primer.
6. Global and Local alignment of two sequences using Needleman-Wunsch Algorithm and Smith-Waterman Algorithm.
7. Pairwise Sequence Alignment using BLAST and FASTA.
8. Multiple Sequence alignment using CLUSTAL W.
9. Phylogenetic Analysis using PHYLIP - Rooted trees & Unrooted trees.
10. Visualizing the Protein Structure using RASMOL.
11. Primary Structure Analysis of a Protein Using ProtParam.
12. Secondary Structure Analysis of a Protein using SOPMA.
13. CHEMDRAW – Chemical Structure Drawing Tool.
14. Homology Modeling
15. Protein- Ligand Interaction- ARGUSLAB.

Core Elective Paper-I

14BOU20A **PHYTOMEDICINE** **60 hours**

100 % Internal

Aim:

To appreciate the Importance of Indigenous medicine.

To Study the Morphology and Uses of Herbs of Medicinal Importance.

Unit I

Definition and Classification -Traditional Systems of Medicine.Classification of Medicinal Plants - Pharmacological and Chemical Basis Collection and Preparation of Natural Drugs for Marketing. Adulteration and Substitution in Medicinal Plant Parts. Types of Medicinal Plants - Algae, Fungi, Lichens, Bryophytes, Gymnosperms and Angiosperms. 15 hours

Unit II

Bioactive Substances - Alkaloids, Glycosides - General Cardiac and Cyanogenic. Quinones, Resins, Terpenoids, Volatile oils, Mucilages, Proteins, Carbohydrates, and Bitter Principles.

Conservation of Medicinal Plants - Necessity for conservation. *In situ* and *Ex situ* Conservation. Seed Bank, Botanical Gardens, Herbal Gardens and Kitchen Gardens.

Value added products - *Aloe* extract and Asafoetida. 15 hours

Unit III

Medicinal Plant Parts - Identifying Features, Available Locality, Flowering and Fruiting Seasons, Medicinal Properties and active Principles of

Entire plants- *Eclipta alba, Phyllanthus amarus.*

Roots - *Glycirriza glabra, Withania somnifera, Rauvolfia serpentina.*

Rhizomes - *Zingiber officinalis, Colchicum autumnale,*

Leaves - *Justicia adhatoda, Vitex negundo, Digitalis purpurea.* 10 hours

Unit IV

Medicinal Plant Parts - Identifying Features, Available Locality, Flowering and Fruiting Seasons, Medicinal Properties and active Principles of

Barks- *Cinnamomum verum, Terminalia arjuna* and *Cinchona officinalis.*

Flowers - *Crocus sativus, Eugenia caryophyllata* and *Mimusops elengi.*

Fruits - *Piper longum, Coriandrum sativum* and *Terminalia bellerica.*

Seeds- *Strychnos nux-vomica, Myristica fragrans* and *Plantago ovata.* 10 hours

Unit V

Remedial plants

Cancer Prohibiting Drugs. Drugs acting on **Digestive Systems**. Laxatives, Carminatives, Gastrointestinal Regulators.

Drugs acting on **Nervous Systems** - Stimulants, Depressants, Hallucinogens.

Drugs acting on **Cardiovascular System**. - Cardiotonics, Antihypertensives.

Drugs acting on **Urinogenetal System** - Diuretics, Aphrodisiac, Oxytosics

Vitamins, Anti-oxidants and Enzymes (Diastase and Papains) 10 hours

Text Books / Reference Books

1. Trease and Evans (1978). Pharmacognosy. Cassell & Collier Macmillan Publications New Delhi.
2. Kumar, N.C. An Introduction to Medicinal Botany and Pharmcognosy, Emkay publications New Delhi.
3. Gokhale, S .B., C. K, Kokate and A. P. Purohit (2000). The Pharmacognosy Nirali
4. Prakashan, Pune.
5. Atal, C. K. and B. M. Kapur (1982). Cultivation and Utilization of Medicinal Plants, RRL (SIR) Jummu Tawi.
6. Vedavathy.S,Mirudhula and Sudhaskar A (1997).Tribal Medicines of Chittoor District
7. (A.P.). Herbal Folklore Foundation. Tripathi.
8. Somasundaram.S (1997). Marathuva Thavaraviyal, Ilangovan Pathipagam, Palayamkottai.
9. Acharya Vipul Rao (2010) Herbal Cure for Common Diseases. Diamond Books. New Delhi.

Core Elective Paper-I

14BOU20B UNDERSTANDING BIOLOGICAL DATABASE 60 hours

Aim: To Understand the Basics of Biological Database.

Unit I

Database: Definition, types, Applications and Classification of Biological Database. 10 hours

Unit II

Sequence database: Genbank, Formats of Sequence Data, Nucleic Acid and Protein Sequence - Data Source, Single Letter Code for Nucleotides and Amino acids. 15 hours

Unit III

Structure Database: Protein Structure Database. CATH and Domain Database Small Molecular Database. 10 hours

Unit IV

Specialized database: OMIM, Literature, Species Specific and Metabolic Pathway Database. 10 hours

Unit V

Model Organism Database: *Arabidopsis thaliana, Cyanobacteria*, Fruitfly and Worm. 15 hours

Text Books / Reference Books

1 K.Mani and Vijayaraj. (2002). Bioinformatics for Beginners. Arthur M.Lesk. (2002). Introduction to Bioinformatics.

SIXTH SEMESTER

14BOU21 PLANT ECOLOGY 60 hours

Aim: To understand the Interaction Between the Environment and Plants.

Unit I

Plants in Relation to their Habitat - Basic Concepts in Ecology. Specialised fields in ecology. Environment in action.

Abiotic Factors – Climatic, Light, Temperature and Moisture.

Biotic Factors - Mutualism, Commensalism, Predation, Herbivory, Competition. Antibiosis and Niche. Edaphic Factors, Ecological adaptations in Hydrophytes and Xerophytes. 15 hours

Unit II

Ecosystem - Ecosystem concept - Structure and Functions of Ecosystem. Trophic Levels- Food Chain and Food Web. Biogeochemical Cycle - Carbon, Nitrogen and Phosphorous Cycles. Physiognomic structure (Pond Ecosystem). 15 hours

Unit III

Community Ecology and Phytogeography - Plant Communities - Characteristics, origin and Development. Characters used in Community Structure. Methods of Studying Community - Quadrat, Line Transect and Point Method, Phytogeography - Vegetations of India. Tropical, Temperate, Deciduous and Mangroves. 10 hours

Unit IV

Biodiversity and Conservation - Biological Diversity- Tropical Rain Forest, Endemism, Extinction, Rare and Endangered Species, Red Data Book, Hot Spot, Biosphere Reserves, Soil Conservation, Chipko and Apico movement. 10 hours

Unit V

Human Impact on Environment

Air pollution - Sources of air Pollution, Kinds of air pollution. Effects of air pollution. Green House Effect, Depletion of Ozone layer. Acid rain and Smog.

Water Pollution - Sources of Pollution, Effects, Eutrophication and Control.

Soil Pollution - Causes, Effects of Pesticides, Solid Wastes, Solid Waste Management. Composting and Recycling. 10 hours

Text Books / Reference books

1. Sharma, P.D. Elements of Ecology, Rastogi Pub., New Delhi
2. Sharma, P.D. Ecology and Environment**,** Rastogi Pub., New Delhi.
3. Weaver, John E.; Clements, Frederic E. (1929). Plant Ecology Hard Cover Publisher, McGraw-Hill, New York
4. Dubey S.K. (2006) A Textbook of Ecology Vedams eBooks (P) Ltd Pitampura New Delhi.

14BOU22 GENETIC ENGINEERING 60 hours

Aim: To understand the techniques of Isolation and Manipulation of Genes from one organism to other.

Unit I

Handling of Nucleic acids - Extraction of DNA from Lambda phages And plant materials, Extraction of RNA from Plant materials, Quantification of Nucleic acids, Labeling of nucleic acids. Electrophoresis of DNA on agarose gel. DNA sequencing technique (Chemical Degradation and Dideoxy Method) . 15 hours

Unit II

Tools of Genetic Engineering -Enzymes - Restriction enzymes, Polymerases and ligases ,**Vectors** - Plasmid and phage vectors for E.coli, (Lambda and M13)
Genetic transformation.Vector dependent and Non vector systems (direct gene transfer) of genetic transformation. 15 hours

Unit III

Isolation of genes, Artificial synthesis of genes, Amplification of gene by polymerase chain reaction, Construction and Screening of DNA libraries, Hybridoma and Monoclonal Antibodies. 10 hours

Unit IV

Handling recombinants - Genetic selection - Chromogenic substrates, Insertional inactivation, Complementation of defined mutations .**Screening** - Nucleic Acid Probes, Screening Clone Banks. **Analysis** - Blotting techniques (Southern, Northern, Western and Dot Blot), mRNA translation *in vitro*. 10 hours

Unit V

Applications - Medicine - Gene Therapy, Genetic Counseling. Preventive Vaccines.
Agriculture – Resistant Varieties and Transgenic Plants.
Livestock - Animal Husbandry and Transgenic Animals. 10 hours

Text Books / Reference Books

1. Gupta, P. K. (1998). Elements of Biotechnology, Rastogi & Co, Meerut. New Nelhi.
2. John, E. Jopthi Prakash (1997). Principals of Genetics and Genetic Engineering, J. P. R. Publications.
3. Ramawat, K.G. (2004). Plant Biotechnology, S. Chand and company LTD. New Delhi.
4. John Jothi Prakash, E. (2006). Outlins of Biotechnology, Emkay Publications, New Delhi.
5. Pramod Kumar Banarjee, (2008). Introduction to Biophysics, S. Chand and Co. New Delhi.
6. Dubey R.C. (2006). Text Book of Biotechnology. S.Chand & Co.New Delhi.
7. Das.H.K. (2004). Textbook of Biotechnology. First Edition. Wiley India Pvt. Limited. New Delhi.

14BOU23 **PLANT METABOLISM** **60 hours**

Aim: To Understand the Basic Molecular Machinery of Plant Cell.

Unit I

Bioenergistics -Laws of Thermodynamics - Gibb`s free energy, Enthalpy and Entropy

Enzymes – Properties, Cofactors - Inorganic, Prosthetic groups and Co-enzymes, Classification and Nomenclature - Activation energy, Lock and Key model, Induced Fit Theory, Rate of enzyme reaction.

Factors Affecting Enzyme Action - Concentration of Substrate, Temperature and pH.

Enzyme Inhibition - Competitive Inhibition, Non - Competitive Inhibition and Allosteric Inhibition. 15 hours

Unit II

Energy metabolism –I

Photosynthesis - Source of energy and energy harvesting mechanism. Electromagnetic nature of light, Photon / Quanta. Absorption of Quanta, Excitation, Meta stable state of electrons, Fluorescence and Phosphorescence.

Photosynthetic Pigments- Chlorophylls and Carotenoids, Absorption and Action Spectrum of Pigments. Light Harvesting Systems. Red Drop and Emerson's Enhancement effect, Antenna Complex and Photosystem I Components, Photosystem II Components, Hill's reaction. 15 hours

Unit III

Biochemistry of Photosynthesis

Light Dependent Reactions – Cyclic, Non Cyclic Photophosphorylations, Flow of electron, ATP generation in Thylakoids, **Light Independent Reactions** - Calvin's Cycle, Stages of C_3 Pathway.Hatch and Slack pathway or C_4 pathway, Comparison of C_3 and C_4 plants. Factors affecting Photosynthesis, Crassulasian Acid Metabolism. 10 hours

Unit IV

Energy Metabolism II

Respiration -Respiratory Substrates and Respiratory Quotients. Glycolytic Pathway, fate of Pyruvate, Aerobic and Anaerobic paths. Kreb's cycle and its link metabolism. Phosphorylation substrate level and Oxidative phosphorylation, Structure of ATP and its significance. Factors affecting respiration. 10 hours

Unit V

Nitrogen and Fat Metabolism - Sources of nitrogen to plants, Nitrogen fixation in root nodules, Reduction of nitrates in plant tissues, Synthesis of aminoacids. Reductive amination and transamination. Beta oxidation of fat. 10 hours

Text Books / Reference Books

1. Salisbury and Ross (1991). Plant Physiology, Thomson Wards Worth, Singapore.
2. Gupta, N. K. and S. Gupta (2000). Plant Physiology Oxford & IBH Publishing Co. PVD - LTD, New Delhi.
3. Verma, P. (2006). Plant Physiology, Emkay Publications, New Delhi.

4. Pandey, S.N. and B. K. Sinha (1993). Plant Physiology, Vikas Publications PVD, LTD, New Delhi.
5. Verma, V. (2007) Text Book of Plant Physiology. New Delhi, Ane Books India,
6. Stryer's Biochemistry, Published by W. H. Freeman and Company.
7. Sarbhai,R.P and B.D.Semwal (1989). A Text Book of Plant Physiology. Ratan Prakash Mandir Eductaional and University Publishers.Agra.
8. Gill.P.S. (2000). Plant Physiology. S.Chand & Co. New Delhi.

14BOU24 HORTICULTURE AND PLANTATION CROPS 45 hours

Aim: To impart basic knowledge about forest and forest regeneration. Understanding horticultural techniques and a few plantation crops.

Unit I

Horticulture - Origin, definitions, scope and impact of Horticulture. Types of horticulture. Methods of propagation-Seeds and Vegetative (cutting, layering and grafting). Propagation by specialized stem and roots- bulbs, corms, tubers, rhizomes and pseudo bulbs). 9 hours

Unit II

Floriculture - Definition and Importance of Floriculture.-Soil and Climate; Propagation; Nursery practices; Planting methods - Cultivation, Harvesting and Storage of flowers (Rose and Anthurium). Common diseases affecting the horticultural crops, Flower arrangement and Bonsai. 9 hours

Unit III

Gardening and Pomology - Types of gardens-Indoor garden, Kitchen garden and Public garden. Pomology- Definition and Importance-Cultivation, Harvesting and Storage of fruits (Banana & Mango). Uses of Growth regulators in horticulture. 9 hours

Unit IV

Plantation Crops - Soil and Climatic Requirement, Varieties, Propagation, Planting systems, shade regulation, Training and pruning, Pest and disease control, Harvesting, processing and yield. 9 hours

Unit V

Importance, Present status and Future Scope of Plantation crops in India. Origin, Distribution, Production methods and uses of Coffee, Tea and Rubber. 9 hours

Text Book /Reference books

1 Kumar**.** N (1977). Introduction to Horticulture, Rajalakshmi Publications, Nagercoil, India.
2 Chadha, K.L. 2001, Handbook of Horticulture, ICAR, New Delhi.
3 Chattopadhyaya, P.K.2001. A text book on Pomology (Fundamentals of fruit growing) Kalyani Publication, New Delhi
4 Christopher, E.P. 2001. Introductory Horticulture, Biotech Books, New Delhi
5 Edmond, J.B. T.L.Senn, F.S. Andrews and P.G.Halfacre, 1975. Fundamentals of Horticulture, Tata MC. Graw Hill Publishing Co.New Delhi
6 George Acquaah, 2002, Horticulture-principles and practices. Prentice-Half of India pvt. Ltd., New Delhi.
7 Parthasarathy, V.A., P.K. Chattopadhyay and T.K. Bose**.** (2006) Plantation Crops, Kolkata, Naya Udyog.

CORE ELECTIVE PAPER - II

14BOU25A **PLANT TISSUE CULTURE** **60 hours**

Aim: Basic Knowledge about Plant Tissue Culture Techniques and Application in Improvement of Crops.

Unit I

Plant Tissue Culture – Laboratory Organization. Sterilization. Media preparation & its types, Totipotency - Differentiation, Dedifferentiation and Redifferentiation. Organ culture - Root, Shoot apex, Ovary, Embryo culture and their applications. Cell suspension culture. 15 hours

Unit II

Growth Regulators - Discovery, Bioassay, Chemical nature, Synthesis, Mode of action, Physiological role, Commercial applications of Auxins, Gibberellins, Cytokinins, Abscissic acids and Jasmonates. 15 hours

Unit III

Callus Culture, Organogenesis, Somatic Embryogenesis, Haploid Production and application, Protoplast Culture - Isolation of Protoplast, Maintenance and Culture. Somatic Hybridization - Protoplast Fusion, Cybrids - uses. Hardening and Acclimatization of TC plants . 10 hours

Unit IV

Tissue culture in Forestry and Agriculture - Micropropagation, Synthetic seeds, Meristem culture for virus free plants. Impact on Agriculture, Cryopreservation. 10 hours

Unit V

Bioreactors - Cell Immobilization. **Secondary Metabolites** - Types of Metabolites, Production of Secondary metabolites of plants and Factors Controlling the Production. Impact of tissue culture industries in India. 10 hours

Text Books / Reference Books

1. Verma, V. (2007) Text Book of Plant Physiology. New Delhi, Ane Books India,
2. Stryer's Biochemistry, Published by W. H. Freeman and Company.
3. Dennis N.Butcher, David. S.Ingram (1976). Plant Tissue Culture, Edward Arnold, London.
4. Narayanaswamy (2008). Plant Cell & Tissue Culture, Tata Mcgraw Hill Publishing Company Limited, New Delhi.
5. Ramawat.K.G.(2000). Plant Biotechnology, S.Chand &Co., New Delhi.
6. Razdan.M.K.(2004). Introduction to Plant Tissue Culture, 2nd Ed.Oxford & IBH Publishing Co Private Limited, New Delhi.
7. Misra.S.P. Plant Tissue Culture. Ane Books Pvt, Ltd.
8. Kumar.U (2011). Methods in Plant Tissue Culture. Agrobios, Jodhpur, India.

CORE ELECTIVE PAPER-II

14BOU25B **PLANT PATHOLOGY** **60 hours**

Aim: To study about the causal organisms and control measures of plant diseases affecting economically viable plants.

Unit I

Nature and Concept of plant diseases, Classification of diseases according to major causal factors (Walker). History of Plant Pathology, Host penetration and entry of pathogens, defense mechanism of plants. 15 hours

Unit II

Enzymes and toxins in plant diseases, Effects of infection on the physiology of host. Dissemination of Pathogens. Symptoms of Plant Diseases. General Control Methods of Plant Diseases. 15 hours

Unit III

Fungal diseases - Causal Organisms, Disease Cycle and Control Measures of White Rust of Crucifers, Rust of Wheat, Wilt of Cotton, Red Rot of Sugarcane, Tikka Disease of Groundnut. 10 hours

Unit IV

Bacterial and Viral Diseases - Causal Organisms, Disease Cycle and Control Measures of Bacterial Blight of Paddy, Citrus Canker, Crown Gall of Stone Fruits, TMV Disease, Yellow Vein Disease of Bhendi, Bean Mosaic Virus. 10 hours

Unit V

Mycoplasma Diseases - Sandal Spike, Citrus Greening, Rice Yellow Dwarf and Little Leaf of Brinjal, A general account of Nematode Diseases. 10 hours

Text Books / Reference Books

1. Mehrothra.R.S. (2003) Plant Pathology, Tata Mc Graw Hill Publishing Company Limited NewDelhi.
2. Dubey R.C and.Maheswari. D.K (2005) A Text Book of Microbiology. S.Chand and Co. Limited NewDelhi.
3. Vashista P.C (2008). Botany for Degree Students 'Fungi'. S.Chand and Co, New Delhi.
4. Bilgrami, K. S. and Dube, H. C. (1990). A Textbook of Modern Plant Pathology. Vikas Publishing House Pvt. Ltd., New Delhi.
5. Butler, E. J. and Jones, S. G. (1949). Plant Pathology. Macmillan & Co., London.
6. Pandey, B. P. (2005). A Text Book of Plant Pathology, Pathogen and Plant Diseases. S. Chand and Co. Ltd., New Delhi.
7. Rangaswamy, G. (1972). Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd.
8. Rangaswamy, G. and Soumini Rajagopalan. (1973). Bacterial Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

14BOU26 **PLANT SCIENCE PRACTICAL III**

1. Technical description of plants at least 2 representatives for each family.
2. Field work: Plant Collection Trips (not less than three days)
3. Collection of plants - Submission of Herbarium (20 sheets) and Field note book.
4. Study of Economically Important Plants.
5. Identification and medicinal uses of available medicinal plants enlisted in the syllabus.
6. Preparation of herbarium (10 plants) of medicinal plants/specimens. To be submitted during practical examination.
7. Nursery practices, green house maintenance, visit to medicinal plant cultivation centers.
8. Preparation of medicinal plant decoctions
9. Preparation if medicinal powders (Sooranam).
10. Preparation of tonic/ Lehiam.
11. Identification of some important active principles
12. Simple Biogas Production Techniques.
13. Mushroom Cultivation.
14. Litmus Milk Test
15. Starch Hydrolysis
16. Record of Horticultural Plants (25 Numbers).
17. Nursery practices and green house maintenance.

14BOU27 **PLANT SCIENCE PRACTICAL IV:**

1. Preparation of Simple Basal Medium - Organ Culture.
2. Bioassay of IAA.
3. Root Induction using IBA.
4. Production of Callus and Induction of Embryoids in culture
5. Visit to Plant Tissue Culture Industry.
6. Study of Morphology and Anatomy of Hydrophytes and Xerophytes.
7. Study of Vegetation by Quadrat and Line Transect Method.
8. Soil characteristics: Soil pH. Carbonate, Nitrate and Moisture Content of the soil.
9. Visit to nearby by forest to study the type of Vegetations.
10. Isolation of plant DNA.
11. Quantification by Spectrophotometric methods.
12. Isolation of RNA.
13. Quantification of RNA.
14. Restriction Digestion of DNA.
15. Separation of DNA fragments on Agarose Gel.
16. Separation of Proteins on Polyacrylamide Gel .
17. Effect of substrate concentration and temperature on enzyme activity (Peroxidase).
18. Estimation of Proteins, Sugars and Aminoacids.
19. Absorption Spectrum of Chlorophyll.
20. Separation of Pigments by Paper Chromatography
21. Rate of Photosynthesis under different quantity and quality of light.

14ZOU03 PLANT BIOLOGY I (FOR ZOOLOGY MAJOR) 45 hours

Unit I

Diversity of Plants - Five Kingdoms of Biological System.
Algae: Study of Vegetative Structure and Reproduction of *Ocillatoria*, *Volvox* and *Dictyota*.
Fungi: *Albugo* and *Aspergillus.* 9 hours

Unit II

Plant Diseases - Symptoms of Plant diseases, Disease Cycle of Tikka Leaf Spot and Rust of Wheat, Bacterial Blight of Paddy.
Structure and reproduction of *Anthoceros, Adiantum* and *Cycas.* 9 hours

Unit III

Medicinal Plants - Active Principles of Medicinal Plants. Uses of Medicinal Plants in Pharmaceutical Industries, Cosmetics, Repellants, and Organic Pesticides.
Identifying Features, Medicinal Properties, and Active Principles of *Justicia adathoda*, *Asparagus recemosus*, *Phyllanthus amarus*, and *Vitex negundo*. 9 hours

Unit IV

Angiosperms - Benthem and Hookers Classification, Characteristics and Economic uses of following Plant Families.
Annonaceae, Brassicaceae, Rutaceae, Leguminosae and Euphorbiaceae 9 hours

Unit V

Rubiaceae, Asclepiadaceae, Acanthaceae, Arecaceae and Poaceae.
9hours

Text Book / Reference books

1. Vashishta, B. R., A. K. Sinha and V. P. Singh. (2008). Botany for Degree Students: Algae. S. Chand & Company Ltd, New Delhi.
2. Sharma,P. D. (1986). Text Book of Taxonomy -. Tata McGraw Hills, New Delhi.
3. Singh V. and D.K Jain (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
4. Sambamurthy.A.V.S.S.(2005) Taxonomy of Angiosperms.I.K.International Pvt.Ltd.New Delhi.
5. Vedavathy.S,Mirudhula and Sudhaskar A (1997).Tribal Medicines of Chittoor District (A.P.). Herbal Folklore Foundation. Tripathi.

14ZOU06 PLANT BIOLOGY II (FOR ZOOLOGY MAJOR) 45 hours

Unit I

Plant Tissue Culture - Laboratory Organisation, Sterilization, Media Preparation.Callus culture, Root culture, Shoot apex culture, Isolation and Culture of Plant Protoplasts. Biotechnology for crop improvement with reference to tissue culture. 9 hours

Unit II

Industrial Microbiology - Industrial production of Citric acid, Alcohol, Penicillin and Mushrooms (*Agaricus* and *Pleurotus*). 9 hours

Unit III

Horticulture I - Principles of Landscape and Garden Designing. Laying and Maintaining lawn. Rock Gardening, Water Garden and Bonsai, Choice and Techniques of Maintaining Indoor Garden. 9 hours

Unit IV

Horticulture II - Propagation, Cultivation, Marketing and Uses of Jasmine, Asteraceae members (*Chrysanthemum*, *Tagetus*) Climbers, Turmeric and Pepper. 9hours

Unit V

Plant Physiology

Photosynthesis - Photosynthetic Apparatus, Pigments, Absorption Spectrum, Light Reaction and Dark Reaction (Calvin Cycle only).

Respiration – Aerobic, Anaerobic and Fermentation.

Plant Growth Regulators - Chemistry, Mode of action and Physiological role of Auxins and Cytokinins. 9 hours

Text Books / Reference Books

1. B. D. Singh**.** (2003).Biotechnology, Kalyani Publishers, Ansari Road, Daryaganj, New Delhi
2. Kumar**.** N (1977): Introduction to Horticulture, Rajalakshmi Publications, Nagercoil, India.
3. A. H. Patel (1985). Industrial Microbiology, McMillan (India) Ltd., Bombay
4. Verma, P. (2006). Plant Physiology, Emkay Publications, New Delhi.

14ZOU08 PLANT BIOLOGY PRACTICAL (FOR I B. SC. ZOOLOGY)

1. Microscopic Observation of Vegetative and Reproductive structures of *Oscillatoria* and *Volvox.*
2. Morphology and Reproduction of *Dictyota* thallus.
3. Microscopic observation of *Albugo* and *Aspergillus.*
4. Morphology and Reproduction of *Anthoceros*.
5. Morphology and Reproduction of *Adiantum*
6. Morphology and Reproduction of *Cycas.*
7. Recording the identifying morphological features of any 10 medicinal plants
8. Identification of plants pertaining to families mentioned under Unit IV and V.
9. Glasswares Sterilization. (Glassware used in Plant tissue culture).
10. Microscopic observation of *Penicillin* and *Aspergillus*
11. Mushroom Cultivation and Observation of the fruit body formation (Paddystraw).
12. Record of 20 Horticultural Plants.
13. Separation of Leaf Pigments by Paper Chromatographic Method.
14. Measuring Rate of Photosynthesis under Different Light Intensities.
15. Study of Fermentation using Kuhne's Vessel.

Non-Major Elective (NME) - EDC

14EDCBOU **Horticulture and Mushroom cultivation** **24 hours**
(Cluster-III)

UNIT – I **5** hours

Horticulture - Origin, definitions, scope and impact of Horticulture. Types of horticulture. Methods of propagation-Seeds and Vegetative (cutting, layering and grafting). Propagation by specialized stem and roots- bulbs, corms, tubers, rhizomes and pseudo bulbs).

UNIT – II **5** hours

Floriculture - Definition and Importance of Floriculture - Propagation; Nursery practices; Planting methods - Cultivation, Harvesting and Storage of flowers (Rose and Anthurium), Flower arrangement and Bonsai.

UNIT – III **5**hours

Gardening and Pomology - Types of gardens; Pomology- Definition and Importance-Cultivation, Harvesting and Storage of fruits (Banana & Mango).

UNIT-IV 5 hours

Mushroom Cultivation - Methods of cultivation – Bed method, Polythene bag method, Field cultivation. Cultivation of Oyster mushroom (*Pleurotus sajor-caju*) and Paddy straw mushroom (*Volvariella volvacea*).

UNIT-V 4 hours

Mushroom - Medicinal uses, Preparation of recipes and Economic importance,

Text Books / Reference Books

1. Chadha, K.L. 2001, Handbook of Horticulture, ICAR, New Delhi.
2. Chandra, R. and M. Mishra. 2003. Micropropagation of horticultural crops. International Book Distributing Co., Lucknow.
3. Chattopadhyaya, P.K.2001. A text book on Pomology (Fundamentals of fruit growing) Kalyani Publication, New Delhi
4. Christopher, E.P. 2001. Introductory Horticulture, Biotech Books, New Delhi
5. Edmond, J.B. T.L.Senn, F.S. Andrews and P.G.Halfacre, 1975. Fundamentals of Horticulture, Tata MC. Graw Hill Publishing Co.New Delhi
6. Kumar**.** N (1977): Introduction to Horticulture, Rajalakshmi Publications, Nagercoil, India.
7. Singh, N.P. 2005. Basic concepts of fruit science. International Book Distribut ing Co., Lucknow.
8. George Acquaah, 2002, Horticulture-principles and practices. Prentice-Half of India pvt. Ltd., New Delhi.
9. Harander Singh. 1991. Mushrooms- The Art of Cultivation- Sterling Publishers.
10. Indian Journal of Mushrooms. Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan.
11. Peter Oei 2000 Mushroom Cultivation III Edition, Backhuyes Publisher USA.
12. Tripathi DP., 2005 Mushroom Cultivation Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
13. Krishnamoorthy AS., Marimuthu T and Nakkern S 2005 Mushroom Biotechnology TNAU Press, Coimbatore, India.
14. Nita Bahl 1988 Handbook of Mushroom Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.