SYLLABUS

For

2 YEARS MASTER PROGRAMME

in

BOTANY (MSB)

[As per CBCS Pattern recommended by UGC]

Effective from Academic Session 2016-2017

School of Biological Sciences (SBOS)

UNIVERSITY OF SCIENCE & TECHNOLOGY, MEGHALAYA

Techno City, 9th Mile, Baridua,Ri-Bhoi,Meghalaya-793101

M.Sc (Botany)
Course content
Credit=90, Total marks=2000

SEMESTER-I

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
MSB-101 (CC-1)	Lower cryptgams (FC)	4	T	30	70	100
MSB-102 (CC-2)	Higher cryptogams, Gymnosperms and Paleobotany	4	T	30	70	100
MSB-103 (CC-3)	Advanced morphology, Anatomy and Taxonomy of Angiosperms	4	T	30	70	100
MSB-104 (SEC-1)	Practical –I Lower Plant Diversity	4	P	30	70	100
MSB-105 (SEC-2)	Practical –II Anatomy, Morphology, Taxonomy of Angiosperms	4	P	30	70	100
Total		**20**				**500**

SEMESTER-II

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
MSB-201 (CC-4)	Molecular Cell Biology	4	T	30	70	100
MSB-202 (CC-5)	Biochemistry andAdvanced Plant Physiology	4	T	30	70	100
MSB-203 (CC-6)	Cytology, Genetics &Plant breeding	4	T	30	70	100
MSB-204 (SEC-3)	Practical –III Biochemistry of Advanced Physiology	4	P	30	70	100
MSB-205 (SEC-4)	Practical –IV Cytology, Cytogenetics, Molecular Biology and Plant Breeding	4	P	30	70	100
Total			**20**			

SEMESTER-III

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
MSB-301 (CC-7)	Plant pathology and Microbiology	4	T	30	70	100
MSB-302 (CC-8)	Biophysical instrumentation, Plant tissue culture, Palynology and Developmental botany	4	T	30	70	100
MSB-303 (CC-9)	Plant Ecology	4	T	30	70	100
MSB-304 (SEC-5)	Practical –V Microbiology, Plant Pathology, biotechnology and Developmental Biology	4	P	30	70	100
MSB-305 (SEC-6)	Practical –VI Plant Ecology	4	P	30	70	100
MSB-306 (GE-1)	(Within SBOS) Biofertilizer and Organic farming	4	T	30	70	100
MSB-307	Discipline specific Elective/ Dissertation (DSE-3)	-	PROJECT	-	-	-
Total		**24**				500

SEMESTER-IV

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
MSB-401 (CC-10)	Biostatistics, Computer application and Bioinformatics	4	T	30	70	100
MSB-402 (DSE-1)	Special paper*(Part I)	4	T	30	70	100
MSB-403 (DSE-2)	Special paper*(Part II)	4	T	30	70	100
MSB-404 (DSE-3)	Projectwork (Dissertation)*	8	PROJECT	60	140	200
MSB-405 (GE-2)	(interdisciplinary) Plant resource utilization and conservation	4	T	30	70	100
HVP740	Human values and Professional ethics	Non Credit Mandatory	-	15	35	50
	Total	24				600

CC: Core Course **DSE:** Discipline Specific Elective

GE: Generic Elective **(**Multidisciplinary Course) **SEC:** Skill Enhancement Course

***A.** Cytology, Genetics and Plant Breeding **B.** Biochemistry and Plant Physiology
C. Angiosperm Taxonomy **D.** Plant Ecology **E.** Microbiology **F**. Mycology & Plant Pathology

MSB-101: Lower Cryptogams

Course outcome:

CO1. **(0.2)** To give the students some basic idea about algal classification, habit, habitat, morphology, reproduction and evolution of algae.

CO2. **(0.2)**Role of algae in soil fertility, algae in industry, algal indicators, blooms, Eutrophication. Biological importance of phytoplanktons and water blooms.Algal culture.

CO3. **(0.2)** Understand about introduction, classification of fungus. Salient features of different classes of fungi.Economic importance of Fungi

CO4. **(0.2)** Introduction, classification of Bacteria, Ultrastructure, Reproduction and nutrition of bacteria. Harmful and Beneficial effect of Bacteria.

CO5: **(0.2)**General account of Virus, ultra structure, Classification, structure and reproduction of Virus. Viral genomes- its type and structure; Viroids, virusoids and Prions. Antiviral agents and interferons.

Course Content: **Credit: 4**

Unit I: Algae

Classification of algae: outline of Fritsch classification. Criteria for algal classification. Role of pigments in classification.

Details of habit, habitat and distribution of algae. Range of thallus structure and their evolution.

Morphology and reproduction of Chlorophyceae,Myxophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae and Xanthophyceae. Evolution of sex in Algae.

Role of algae in soil fertility, algae in industry, algal indicators, blooms, Eutrophication. Biological importance of phytoplanktons and water blooms.Algal culture.

Unit II: Fungi

Introduction and historical account, classification of Gwynne Vaughan and Ainsworth.

Salient features of different classes of fungi.

Range of vegetative structure and reproduction in fungi. Life cycles of Penicilium, Puccinia, and Alternaria.

Mycorrhizal association and it's application in forestry and agriculture.

Economic importance of Fungi.

Unit III: Bacteria

Introduction, general account and occurrence of bacteria; recent developments in classification of Bacteria; Ultrastructure of bacteria; shape and structural diversity.

Reproduction and nutrition of bacteria

Harmful and Beneficial effect of Bacteria.

Unit IV Virus

General account of Virus (TMV and Bacteriophage).- ultra structure, capsid and its arrangements, types

Classification, structure and reproduction of Virus.
Viral genomes- its type and structure; Viroids, virusoids and Prions.
Antiviral agents and interferons.

Unit V: Lichen

Introduction, general description, classification,distribution and thallus structure.
Reproduction of Lichen: Vegetative, Asexual and Sexual reproduction. Ecological significance and role in succession and Monitoring pollutants and economic importance of Lichen.

Suggested books:

1. Textbook of Algae. B.P Sarabhai, C.K Arora, Anmol Publishing Pvt. Ltd. New Delhi
2. Textbook of Algae.O.P Sharma, Tata McGraw Hill Company, New Delhi.
3. Microbiology- Concept and application, M.J.J. Pelczer., E.C.S. Chang & N. R. Krieg, 1993. McGraw Hill Company, New York.
4. Microbiology. L.M. Prescott, J.D. Harley and D.A. Klein, 1999. McGraw Hill Company, New York.
5. Botany for degree students Algae. B.R Vashista, A.K. Sinha, S. Chand Publishing, New Delhi.
6. Microbiology, Fundamentals and Applications. Ronald M. Atlas,Surajeet publication (2012) Vol I &VolII , 5th Ed. Prentice Hall.
7. Botany for degree students. A.C Dutta, Oxford publication.
8. Text book of fungi. O.P Sharma, Tata McGraw Hill Company, New Delhi.
9. Studies in Botany-Vol-I. J. N. Mitra, D. Mitra and S.K.Chowdhuri, D. N. Moulik Publishing, Kolkata.
10. An introduction to virus. S.B Biswas, Vikas Publishing house, New Delhi.
11. The structure and reproduction of- The Algae. F.E. Fritsh (Vol-II), Vikas Publishing house, New Delhi, Bombay, Calcutta, Kanpur, Bangalore.
12. Textbook of Virology by A J Rhodes. The Williams & Wilkins
13. Matthews' Plant Virology by Roger Hull, Elsevier
14. Understanding Viruses by Shors, J & B.

Paper code: MSB-102

Paper title: Higher cryptogams, Gymnosperms and Paleobotany

Course outcome

CO1. **(0.2)** To give the students some basic idea about the origin, evolution, classification of the group, its comparative morphological, anatomical and reproductive differences within the group and finally the application of Bryophytes.

CO2. **(0.2)** Deals with the basic understandings of the origin and evolution of pteridophytes, its steller evolution and its types, telome concept, origin of seed habit in pteridophytes.

CO3. **(0.2)** The students will have a understandings of classification of vascular cryptogams, morphological, anatomical and reproductive diversity of pteridophytes.

CO4. **(0.2)**To give students some basic understandings of classification and salient features of major taxa of Gymnosperm,its characteristics, affinities and relationships among different taxa and finally the economic importance of Gymnosperms.

CO5. **(0.2)** It was designed to give an understanding of geological time scale, fossilization process, classification and nomenclature of fossil plants, techniques in studying fossils.

Course Content: **Credits: 4**

Unit I: Bryophytes

Origin, evolution, classification of Bryophyta. Comparative morphological, anatomical and reproductive study of gametophytes and sporophytes of Bryophytes. Evolution of sporophytes of Bryophytes. Bryophytes as pollution indicator and monitoring.

Unit II: Pteridophyte I

Origin and evolution of pteridophytes; Steller evolution and types of stele in pteridophytes, Telome concept. Heterospory and origin of seed habit in pteridophytes. Classification of vascular cryptogams.

Unit III: Pteridophyte II

Morphological, anatomical and reproductive diversity, soral evolution in ferns; gametophytic structure in eusporangiate and leptosporangiate forms.

Unit IV: Gymnosperms

Gymnosperms classification and salient features of major taxa; characteristics, affinities and relationships of Cycadofilicales, Bennettitales and Cordaitales. Characteristics, affinities and relationships of Ginkgoales, Coniferales, Taxales and Gnetales. Economic importance ogf Gymnosperms.

Unit V: Paleobotany

Geological time scale, fossilization process, techniques in studying fossils. General account, anatomy and reproduction of Psilophyta (Rhynia), Lepidodendrales (Lepidodendron) and Sphenophyllaes (Sphenophyllum), Cycadofilicales (Lyginopteris), Bennettitales (Williamsonia) and Cordaitales (Cordaites) .

Suggested books:

1. Morphology of Pteridophytes,Hutchinpn Univ. Liabray (1966) -K.R. Spome,
2. An introduction to paleobotany- C.A. Arnold,
3. An introduction to Embryophyta&Bryophyta, Surajeet Publication,(2012), Vol I &Vol II,-N.S Pahrihar.
4. Botany for Degree Students Bryophyta,S. Chand. (2010) ,Ist Ed, B.R Vashishta, A.K Sinha.
5. Botany for Degree Students Pteridophyta, S. Chand. (2010) , Ist Ed P.C Vashistra, A.KSinha, Anil Kumar.
6. An introduction to Pteridophyta, Vikash Publ. (1999), 2nd Ed. A. Rashid.
7. Studies in Botany-(2005)- S.K. Guna and S.K. Chowdhary, Moulik Library Vol-I
8. College Botany- VolII ,New Central Book Agency,(2006), 6th Ed.H.C. Gangulee, K. S. Das

Paper code: MSB-103

Paper title: Advanced Morphology, Anatomy and Taxonomy of Angiosperms

Course outcome

CO1. **(0.2)** Studying plant morphology student will be benefitted to identify plants (visual identification) properly when they go for field work for collection of plants for different research works. Proper identification and classification is important in the fields like genetics, ecology, physiology, axonomyi and evolutionary biology.

CO2. **(0.2)**Taxonomy helps to organize plants into similar groups. So it becomes easier to study and place a new species whenever it is discovered during any research work. It also allows us to identify, group and properly name an organism through a standardized classification system.

CO3. **(0.2)** As Taxonomy is the "Mother of plant science", it helps them to study all the applied disciplines of plant sciences such as Agriculture, Horticulture, Forestry, Pharmacognosy, Biotechnology, etc.

CO4. **(0.2)**By studying plant tissues and cells (anatomy) they will learn how the plants constructed and how they work. These studies are very important because they lead to be a better understanding of how to take care for plants and fight plant diseases.

CO5. **(0.2)** Plant morphology helps to know the different types and forms of leaves, flowers, fruits, seeds, etc., which is an identifying marker for closely related species.

Course Content: **Credits: 4**

Unit 1:

Cell wall and origin of cell wall. Ultrastructure and function of cell wall. Tissue and Tissue system (meristematic and permanent). Secondary growth in monocot and dicot stem. Anomaly secondary growth. A critical study of the current ideas on the origin of angiosperms, origin and evolution of inflorescence and flower, co-evolution of flower vis-à-vis pollinators, special type of inflorescence, origin and evolution of stamens, origin and evolution of carpels, different types; types of ovary, evolution of placentation types, inferior ovary- foliar and axial concepts.

Unit II:

Floral anatomy, floral meristem and floral development. Periderm: Origin and activity; rhytidome, protective tissue in Monocotyledons, bark and cork; Cambium: origin, function. Anatomical response to mineral deficiency, response to plants to wounds and invasion by microbes. Nodal anatomy, root –stem transition in angiosperm.

Unit III:

Intoduction to plant taxonomy and systematic, objectives, goals, aims of plant axonomyi, Hierarchial categories of taxonomy, Chronological development of Taxonomy in India. Classification- Ranks Types of systems of classification – artificial, natural, phylogenetic by Linnaeus, Bentham and Hooker's system. A.W. Eichler, Engler and Pravtt., Hutchinson. Current systems of classification- Takhtajan- Cranquist Thorne.

- Taxonomic Structure
- Plant collection and specimen preparation.
- Herbarium, Major Indian Herbarium, Function pf Harbaria, precautions.
- Botanical library
- Botanical Gardens
- Botanical survey of India, History, axonomyion and publication.

Unit IV: Monocotyledons

General characters and distringushing characters of families- Poaceae, Cyperacae – comparion. Musaceae, Zingibaeraceae and their comparison, Aracaea, Aracaceae, Commelionaceae, liliaceae. Orchidaceae- it is the highly evolved family among monocots.

Unit V: Dicotyledons

Ranunculaceae, Magnoliaceae, Annonaceae and their comparison. Ranunculaceae as a primitive family. Papaveraceae, Brassicaceae, Capparidaceae and their comparison. Rosales, Febaceae and its sub-families. Economic importance of the family Lamiaceae, Verbenaceae, Solanaceae, Scrophulariaceae, Acranthaceae, Rubiaceae, Cucurbitaceae, Rutaceae, Apocynaceae. Asteraceae- as the highly evolved family among dicots.

Suggested books:

1. Botany for Degree Students Gymnosperms. P.C Vashista, A.K Sinha, A. Kumar
2. An introduction to systematic Botany & Ecology. J.N Mitra
3. PlantTaxnomy.Dr. N.B Saxena, S.Saxena
4. Modern plant axonomy. N.S Subrahmanyam
5. Study in botany. D.Mitra, J.N Mitra, S.K Chowdhuri

Paper code: MSB-104
Practical I
Paper title: Lower Plant Diversity

Course outcome

CO1: (0.2) To give the students some detail idea about algal classification, vegetative and reproductive structures of algae.

CO2: (0.2) To give the students some detail idea about fungal and bacterial classification, vegetative and reproductive structures of fungi. Preparation and study of temporary and permanent slides of fungi and bacteria.

CO3: (0.2) To give the students some detail idea about bryophytal classification. Preparation and study of temporary and permanent slides of vegetative and reproductive structures of various genera of bryophytes.

CO4: (0.2) To give students some basic understandings of culture of algal cells and estimation of their growth

CO5: (0.2) To give students practical understandings of various plant specimens under various genera according to the syllabus in the field study (local) by specimen collection, preservation and study in the field.

Course Content: **Credit-4**

Unit 1:

1. Study of vegetative and reproductive structures of the genera representing the syllabus of MSB-01, 02. To be performed dissection, sectioning drawing, description and identification of the specimens supplied. Prepare permanent slides
2. Algae
3. Fungi
4. Bacteria
5. Bryophytes

Unit 2:

1. Culture of algal cells and estimation of their growth by cell counting method.
2. Field study (local) specimen collection, preservation and specimen submission in the examination.

Suggested books:

1. A Text book of practical Botany-II, Dr. Ashok M. Bendra& Dr. Ashok Kumar, 7th Ed. (2004)
2. Modern practical Botany, Vol I & Vol II, S. Chand. (2010) , Ist Ed
3. Modern practical Botany, VollI, By B.P. Pandey (2010),S. Chand. & Company pvt. Ltd

Paper code: MSB-105
Practical II
Paper title: Lower Plant Diversity

Course outcome

CO1: (0.2) To give the students some detail idea about specimens of various genera of pteridophyte, gymnosperms by performing dissection, sectioning drawing, description and identification of the specimens

CO2: (0.2) To give the students some detail idea about various angiospermic genera. Students learn about various monocot and dicot flora by performing dissection, sectioning drawing, description and identification of the specimens.

CO3: (0.2) To give the students some practical knowledge about Morphoanatomical adaptive features of hydrophytes and xerophytes.

CO4: (0.2) Preparation of permanent slides of various specimens of pteridophte, gymnosperms and angiosperms.

CO5: (0.2) To give students practical understandings of various plant specimens under various genera according to the syllabus in the field study (local) by specimen collection, preservation and study in the field and preparation of field report.

Paper title: Anatomy, Morphology, Taxonomy of Angiosperms

Course Content: **Credit-4**

Unit 1:

1. Study of vegetative and reproductive structures of the genera representing the syllabus of MSB-02, 03. To be performed dissection, sectioning drawing, description and identification of the specimens supplied.
2. Morphoanatomical adaptive features of hydrophytes and xerophytes.
3. Prepare permanent slides of
   Pteridophytes
   Gymnosperms
   Angiosperms

Unit 2:

1. Field study
2. Submission of field report

1. Practical Book on Botany, By M. Islam, Society Green Cover, Ist Ed. 2009.
2.Modern practical Botany, VollI, By B.P. Pandey (2010),S. Chand. & Company pvt. Ltd

Suggested books:

1. A Text book of practical Botany-II, Dr. Ashok M. Bendra& Dr. Ashok Kumar, 7th Ed. (2004)

2. Modern practical Botany, Vol I &Vol II, S. Chand. (2010) ,Ist Ed

3. Modern practical Botany, VollI, By B.P. Pandey (2010),S. Chand. & Company pvt. Ltd

Semester II

Paper code: MSB-201
Paper title: Molecular Cell Biology (FC)

Course outcome:

CO1. **(0.2)** Molecular biology plays important role in understanding formations, actions, and regulations of various parts of cells which can be used to efficiently target new drugs, diagnosis disease, and understand the physiology of the cell.

CO2. **(0.2)**This branch use large-scale, systems-level, and high-throughput datasets to derive new biological insights not easily obtained by other approaches

CO3. **(0.2)**It is used to analyze and help solve murders and assaults in forensic medicine.

CO4. **(0.2)**DNA-based technology offers a wide variety of new diagnostic approaches to infectious disease.

CO5. **(0.2)** Recombinant DNA technology offers many different new approaches to the development of vaccines.

Course Content: **Credit: 4**

Unit 1: Techniques in cell biology:

Microscopy: Principles of microscopy, Light microscope: its principles and uses.
Phase contrast microscope, fluorescence microscope.
Electron microscope: Transmission electron microscope (TEM) and Scanning electron microscope (SEM).

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Unit 2: Cell components and their functions

Cell and cell organization.
Protoplast- physical and chemical nature, Structure and function of plasma membrane, Nucleus-structure, composition, function, chromatin structure in eukaryotes, Karyotype; Lampbrush and Polytene chromosome; heterochromatin, euchromatin
Cellular organelles (Mitochondria, Golgi bodies, Endoplasmic reticulum, Lysosome, Vacuoles).
Chloroplast: structure, function.
Cytoskeleton.

Unit 3: Nucleic acid

Double helical structure of DNA; A, B, Z DNA; DNA replication in prokaryotes and eukaryotes; DNA damage and repair; DNA packaging; centromere, telomere; C-value paradox; Structure of RNA: mRNA, rRNA and tRNA; repetitive DNA; interrupted genes; gene families; transposons;

Unit 4: Protein synthesis

Machinary and mechanism of protein synthesis.Autogenous regulation of ribosomal protein synthesis. Operon concept, post transcription and translational modifications.

Unit 5: Biochemical and Evolutionary genetics

In-born errors of metabolism and gene therapy- metabolic pathways; inherited diseases; Hardy-Weinberg law; inbreeding; outbreeding, assertive mating; changes in allele frequencies; genetic equilibrium; Lamarckism; Darwinism; The synthetic theory of evolution; Wiseman's theory and molecular evolution.

Suggested books:

1. Lehninger Principle of Biochemistry (2004). MichealM.Cox and David L. Nelson.4th Edition, W.H., Freeman and Company, New York, USA.

2. Molecular biology of the gene (2008). James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gam, Michel Levine, Richard Losick. 5th Edition, Pearson Education Inc and Dorling Kindersley Publishing.
3. Molecular biology of the cell (2008). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. 5th Edition, Garland Science Publisher.
4. Genomes 3 (2006). T. A. Brown. Garland Science Publisher.
5. Essential genetics: A genomics perspective (2011). Daniel L. Hartt. Jones and Bartlett Publisher.
6. Transcriptional regulation in eukaryotes concepts strategies and techniques (2009). Michel F. Carey, Craig L. Peterson and Stephen T. Smale. 2nd Edition, Cold Spring Harbour Laboratory Press.
7. Cell and Moleccular biology (2011). E.D.P. De Robertis and E. M.F. De Robertis, Jr. 8th Edition, Wolters Kluwer (India) Pvt. Ltd.
8. Molecular biology principles and applications of Recombinant DNA (2001). Bernard R. Glick, Jack J. Pasternak, 2nd Edition, ASM Press, Washington.
9. Genes IX (2006). Benjamin Lewin. Jones and Bartlett Publishers.
10. Essentials of molecular biology (1993). David Freifelder and George M. Malacinski. 2nd Edition, Jones and Bartlett Publishers.
11. Molecular cell biology (2008). H. Lodish, A. Berk, C A. Kaiser, M. Kreiger, M.P. Scott, A. Bretscher, A. Ploegh, P. Matsudira. 6th Edition, W. H. Freeman and Company, New York.
12. Biological Instrumentation & methodology(Tools and Techniques of Biology) (2012). P.K. Bajpai. S Chand & Company Pvt Ltd, Ram Nagar, New Delhi-110055

Paper code: MSB-202
Paper title: Biochemistry and Advanced Physiology

Course outcome:

CO1. **(0.2)**To get detail Biochemical knowledge about carbohydrate, protein, lipids, vitamins and enzymes as well as uses of various vitamins as coenzymes

CO2. **(0.1)**Understand the basic physiological relationship of Plant, water and soil and translocation of organic solutes Mechanism of stomatal transpiration.

CO3. **(0.2)** Understand the basic biochemical and physiological knowledge about the utility of different minerals present in the soil for the growth and development of plants and the deficiency symptoms of micro and macro nutrients to plants

CO4. **(0.2)**Understand the detail knowledge about the biochemistry and physiology of photosynthesis, c and respiration i.e., breakdown of sugar: Glycolysis, Kreb's cycle, electron transport chain, ATP formation, photorespiration, gluconeogenesis.

CO5. **(0.2)**To gather the detail knowledge about Nitrogen metabolism and physiological role of phytohormones in the growth and development of plants

CO6. **(0.1)**Understand detail knowledge about the physiology of flowering, scenescens and abscission in plants and dormancy of seed, Phytochrome, Biological rhythm.

Course Content: **Credit: 4**

Unit 1:

Carbohydrate: Classification, structure and function of monosaccharides, disaccharides, oligosaccharides and poly-saccharides. Structure and functions of protein, amino acids as building blocks, peptides and their sequences, concept of active site. Structure and function of lipids, fatty acids and glycerides, phospholipids, sterols and terpenes, sphingolipids. Enzymes: Classification, purification, kinetics. Vitamines as coenzymes.

Unit 2:

Absorption of water and mineral salts and their translocation in plants. Partitioning and control mechanism in transport of organic solutes.Mechanism of stomataltranspiration.Mineral nutrition: Major and micro nutrients, role of major elements in the physiology of higher plants; deficiency and toxicity symptoms.

Unit 3:

Photosynthesis: Mechanism of photosynthesis, pigment protein complexes, mechanism of pigment system function, cyclic and non-cyclic electron flow, photophosphorylation; C_3, C_4 and CAM pathways of carbon fixation. Respiration: Glycolysis, Kreb's cycle, electron transport chain, ATP formation, photorespiration, gluconeogenesis.

Unit 4:

Nitrogen metabolism: Mechanism of N_2- fixation, NO_3 assimilation, the nitrogenase system, conversion of nitrate to NH_3, assimilation of NH_3.Plant growth regulators: Auxins, gibberellins, cytokinins, abscisic acid and ethylene- isolation, mechanism of action and physiological effects.

Unit 5:

Plant growth and development: Physiology of flowering- Photoperiodism and vernalization. Phytochrome, cryptochromes.Biological rhythms, scenescence and abscission. Germination and dormancy: Factors of seed and bud dormancy- Methods of breaking dormancy, germination stimulators and inhibitors.

Suggested books:

1.Plant Physiology (1985).-Frank B.Salisbary and Cleon W.Rose.Wadsworth Pub. Co., 1985

2. Outline of Biochemistry (2009) - Eric.E.Conn, Paul K. Stumpf. 5th ed,John Wiley & Sons.

3. Lehninger Principle of Biochemistry (2004) - MichealM.Cox and David L. Nelson.4th Edition, W.H., Freeman and Company, New York, USA.

4. Biochemistry (2011) - U.Satyanarayana and U.Chakrapani. Book and Allied (P)Limited.

5. Biochemistry (2011) - Jeremy M. Berg, John L. Tymoczko,LubertStryer. W. H. Freeman (Publisher).

6. Plant Physiology (2000) - P.S.Gill. S. Chand, Limited.
7. Plant Physiology (2002) - RamdaneDris and Catherine Barry-Ryan. Science Publishers.
8. Text book of Biochemistrywith clinical correlations (2010) - Thomas M.Devlin, Wiley.
9. Introduction to Plant Physiology (2004) - W. C. Hopkins. 3rd ed. John Wiley & Sons, New York.
10. PhytochemistryVol.I, II and III (1976) - P. Miller. Van Nostrand Reinhold Company.
11. Research experience in Plant Physiology, a laboratory manual (1974) - T.C. Moore.Springer-Verlag, New York.
12. The Plant Physiology (2006) - LTaiz. and F. Ziegler.4th ed., Sinauer Associates Inc.Publishers, Massachusetts, USA.
13. Biochemistry of Plants. A Comprehensive Treatise (1981) - P.K. Stump and E. Conn.Vol. 7.Academic Press. New York.
14. Phytochrome and Photomorphogenesis (1975) - H. Smith.McGraw-Hill.
15. Physiology of Plant Growth and Development (1969) - M. B. Wilkins.McGraw- Hill, New York.

Paper code: MSB-203
Paper title: Cytogenetics and Plant breeding

Course outcome:

CO1. **(0.2)** To understand basic principles of Mendelian inheritance.

CO2. **(0.2)** To study cell division & chromosome segregation

CO3. **(0.1)** To explore the multifactorial inheritance.

CO4. **(0.2)**To acquire the chromosome structure, chromatin organization and variation.

CO5. **(0.2)**To learn the concepts of Linkage concept of sex determination and sex linked inheritance.

CO6. **(0.1)**To gain knowledge about the organellar inheritance.

Course Content: **Credit: 4**

Unit 1:

General account, structure and function of chromosome, special chromosome.

Cell division –importance of cell division, cell cycle.
Mitosis-different stages.
Meiosis-different stages, role of meiosis in inheritance.

Unit 2:

Mendel's law of inheritance, chromosomal theory of heredity.
Gene and gene interactions (epistasis, supplementary, complementary and duplicate genes), multiple alleles.
Linkage and crossing over, extra nuclear inheritance.
Sex chromosome and sex determination.
Chromosomal aberrations: structural and numerical, polyploidy: euploidy and aneuploidy, their importance in inheritance.
Mutation, Types of Mutation and Mutagens.

Unit 3:

Cell signaling: cell surface receptor; G-protein coupled receptors; secondary messengers and signal transduction pathway.

Unit 4:

Principles: self pollinated plants- selection, hybridization (techniques and consequences).
Principles: Cross pollinated plants: selection, heterosis and inbreeding depression.
Methods: self pollinated plants- mass selection, pureline selection, pedigree selection, bulk method, backcross method.
Methods: cross pollinated plants-population improvement, hybrid and synthetic varieties.

Unit 5:

Techniques of DNA finger printing and genetic marker development (RAPD, RFLP, AFLP, SSR, SNP) and applications of genetic fingerprinting.

Suggested books:

1. Principles of Plant Breeding(1999) 2nd Ed. By, Allard R. W. , John Wiley and Sons.
2. Principles of Genetics (2009),Kalyani publication, New Delhi, B.D.Singh
3. Plant Breeding, Principles and Methods,(2000) Kalyani publication, B.D.Singh, New Delhi
4. Genetics, 2012, 6th Ed., International Students Version, Snustad P.D. & Michael & Simmons.

Paper code: MSB-204

Practical III

Paper title: Biochemistry of Advanced Physiology

CO1. **(0.2)**To get detail practical knowledge about Separation and identification of sugars and amino acids by paper chromatography.
CO2. **(0.2)**To learn how to determine water potential of plant tissue

CO3. **(0.2)** To learn how to determine RQ of different seeds.

CO4. **(0.2)** To learn how to determine Chlorophyll- a, Chlorophyll- b and total Chlorophyll and carotenoid.

CO5. **(0.2)** To learn how to estimate catalase and peroxidase enzyme content from plant tissue.

Course Content: **Credit-4**

Unit 1:

1. Separation and identification of sugars by paper chromatography.
2. Separation and identification of amino acids by paper chromatography method.
3. Determination of RQ of different seeds.
4. Determination of water potential of plant tissue by liquid immersion method.
5. Study of structure and distribution of stomata of both dicot and monocot leaves.

Unit 2:

1. Measurement of transpiration by Cobalt chloride method.
2. Determination of Chlorophyll- a, Chlorophyll- b and total Chlorophyll and carotenoid.
3. Estimation of catalase activity in plant tissue
4. Estimation of peroxidase activity in plant tissue.

Paper code: MSB-205
Practical IV
Paper title: Cytology, Cytogenetics,
Molecular Biology and Plant Breeding

Course outcome:

1. CO1. **(0.2)** To understand how to prepare of mitotic and meiotic spreads and analysis of various stages of cell division
(Allium and Rhoeo, Wheat/Rice).

CO2. **(0.2)** To study how to isolate genomic DNA from plant materials, purification and estimation

CO3. **(0.2)** To study induced and natural chromosomal aberrations.

CO4. **(0.2)**To learn the method of protein estimation. How to construct linkage map from available data

CO5. **(0.2)**To learn the floral morphology and flower structure and also to learn hybridization techniques.

Course Content: **Credit-4**

Unit 1:

2. Preparation of mitotic and meiotic spreads and analysis of various stages of cell division (Allium and Rhoeo, Wheat/Rice).
2. Isolation of chloroplasts
3. Isolation of genomic DNA from plant materials, purification and estimation.
4. Working out of genetical problems.
5. Studies of induced and natural chromosomal aberrations.

Unit 2:

1. Construction of a linkage map using available data.
2. Study of floral morphology and flower structure in crop plants-rice, pulses, solanum.
3. Practice of hybridization technique in self and cross pollinated plants.
4. Isolation of protein sample from plant tissue, quantitative estimation of protein by Lowry's method.

Semester II

Paper code: MSB-301
Paper title: Plant Pathology and Microbiology

Course outcome:

CO1. **(0.2)**Understanding introduction to plant pathology, classification of diseases, process of infection and pathogenesis.

CO2. **(0.2)**To get knowledge about host parasitic infection, defense mechanism in plants.

CO3. **(0.2)**To get knowledge about biotechnological approaches to disease resistance and major diseases in plants.

CO4. **(0.1)** Understanding the introduction, scope of microbiology, use of microbiology I human welfare.

CO5. **(0.1)**Understanding control of microorganism, microbial techniques.

CO6. **(0.2)** To get knowledge about Immuno and immune systems.

Course Content:

Credit: 4

Unit I:

Introduction to plant pathology, Classification of plant diseases based on;
(a) Major causal agents - biotic and abiotic,
(b) General symptoms.
Process of infection and pathogenesis
(a) Penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic.
(b) Host-parasite interaction, enzymes and toxins in pathogenesis
Defense mechanism in plants.
Pre-existing structural and biochemical defense mechanisms, lack of essential nutrients.Induced, structural and biochemical defense mechanisms.
Plant disease management: exclusion, eradication and protection. Chemical and biological means of disease control.
Biotechnological approaches to disease resistance.

Unit II:

Major diseases in plants
(a) Cereals: Rice - blast disease, bacterial blight
(b) Vegetables: Chilly - leaf spot; Ladies finger - vein clearing disease.
(c) Fruits: Citrus - bacterial canker;
(d) Spices: Ginger - rhizome rot; Pepper - quick wilt
(e) Oil seeds: Coconut - grey leaf spot, bud rot disease.
(f) Rubber yielding: *Heveabraziliensis* - abnormal leaf fall, powdery mildew.
(g) Sugar yielding: Sugarcane - red rot
(h) Cash crops: Arecanut - nut fall disease.

Unit III:

Introduction to microbiology.Scope of microbiology, microbiology in human welfare, bioterrorism.
Microbial diversity: Microbial taxonomy and phylogeny
Major groups and their characteristics (Five kingdom system and three domain system of classification).

Unit IV:

Bacrteria, Culture of microorganisms.Methods for isolating pure cultures types of culture media, enrichment culture techniques, maintenance and preservation of pure cultures.

Unit V:

Application of Microbiology: application of microbiology in industrial, agriculture and waste management: symbiotic nitrogen fixation, Mycorriza and VAM fungi.
Food Microbiology: Contamination and spoilage of food products, Food preservation methods.
Industrial Microbiology: Industrial production of alcohol, citric, acid, solvents, amino acids, enzyme, Antibiotics.

Suggested Books:

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, Mc Graw Hill 2004
2. Microbiology: Principles and Explorations by Jacquelyn Black 7e, John Wiley & Sons, inc.,2000
3. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis, 5th edition Tata,1999
Mac Graw Hill.
4.Biology of microorganisms Madigan, Markinko,Dunlap,Clark 12th edition 2009, Pearson Benjamin Cumming.
5. Microbiology by Michael J Pelczar , Chan, Kreig 5th edition,2006 Tata Mac Graw Hill
6.Microbiology by Tortore, Funke,Case (th edition 2009, Pearson.
6.Molecular Genetics of Bacteria: Snyder & Champness,2006
7. Molecular Biology by Freifelder
8. Genomes 3: T. A. Brown
10. Soil Microbiology by Subba Rao. India Book House Pvt Ltd
11. Environmental Microbiology by Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press
12. M.C., Alexender, Introduction to Soil Microbiology ; 2nd edition John Wiley New York,1977.
13 Plant Pathology.J.C Walker , 1999 by The National Academy Press Washington.
14. Plant Pathology by G.N Agriose: January 2000, Academic Press

Paper code: MSB-302

Paper title: Biophysical instrumentation, Biotechnology and Developmental Botany

Course outcome:

CO1. **(0.2)**The branch biophysical instrumentation seeks to explain biological function in terms of the molecular structures and properties of specific molecule.

CO2. **(0.2)**Molecular biophysics typically addresses biological questions similar to those in biochemistry and molecular biology, seeking to find the physical underpinnings of biomolecular

phenomena.

CO3. **(0.2)** These *instruments* and techniques even can view and manipulate single molecules and measure their behavior.

CO4. **(0.2)** Plant tissue culture can be used to genetically modify crops to produce high quality crops.

CO5. **(0.2)**Modern developmental biology studies the genetic control of cell growth, differentiation and morphogenesis, which is the process that gives rise to tissues, organs and anatomy.

Course Content: **Credit: 4**

Unit 1. Principles and applications of bio instruments

Basic principles and applications of pH meter; UV-visible spectrophotometers; Centrifuges (Table top centrifuge and ultra centrifuge); Gel Electrophoresis: SDS PAGE; Immunoassay systems, ELISA; X-ray crystallography; Chromatography: Principles and applications; Paper chromatography, Thin layer chromatography (TLC), Column chromatography; high performance liquid chromatography (HPLC).

Unit 2. Plant tissue culture

Introduction; History of Plant Tissue Culture and Biotechnology; Scope and Importance of Biotechnology; Tissue and Cell Culture; Micropropagation; Anther Culture; Somaclonal Variation; Production of Secondary Metabolites; Protoplasts Isolation and Fusion: Somatic Hybrids; Cryopreservation; Hydroponics;

Unit 3. Principles and tools of recombinant DNA technology

Restriction endonucleases; ligases; DNA modifying enzymes; Vectors: plasmids, phages, cosmids, artificial chromosome vectors; binary and shuttle vectors; cDNA and genomic libraries; Isolation of specific genes from bacteria and higher plants; cloning;

Unit 4. Techniques of Genetic Engineering

Transfer of recombinant DNA into bacterial cells; transformation, selection (screening) of recombinants; Methods for Gene Transfer; Generation of Transgenic Plants and their identification; Polymerase Chain Reaction (PCR machine); Blotting techniques: Southern blotting; Northern blotting and Western blotting; Expression of cloned DNA;

Unit 5. Developmental botany

Male gametophyte: Pollen development, pollen tube growth and guidance; pollen storage; Female gametophyte; Types of embryo sacs; structure of embryo sac cells; Pollination, pollen-pistil interaction and fertilization; Seed development and fruit growth; apomixis, polyembryony, somatic embryogenesis.

Suggested books:

1. Bajpai PK (2012) Biological Instrumentation & methodology(Tools and Techniques of Biology), S Chand & Company Pvt Ltd, Ram Nagar, New Delhi-110055
2. Narayanan P(2008) Essential of biophysics, New Age International Publishers, New Delhi.
3. Sadasivam S &ManickamA(2009) Biochemical Methods,New Age International Publishers, New Delhi.
4. Thieman WJ &Palladino MA (2009) Introduction to Biotechnology, Second Edition Pearson.
5. Satyanarayana U (2010) Biotechnology, Books and alied (P) Ltd. Kolkata.
6. Lieber DC (2006) Introduction to Proteomics: Tools for New Biology; Humana Press, NJ.
7. Sambrook J and Russell DW (2001). Molecular Cloning – A Laboratory Manual, Vols I – III,Cold Spring Harbor Laboratory, USA.

8. Singer M and Berg P (1991). Genes and Genomes: A Changing Perspective; University Science Books, CA, USA
9. Herman EB (2008) Media and Techniques for Growth, Regeneration and Storage 2005-2008. Agritech Publications, New York, USA.
10. Raghavan V (1997) Molecular Embryology of Flowering Plants, Cambridge Univ. Press.
11. Raghavan V (2000) Developmental Biology of Flowering Plants, Springer Verlag, NewYork.
12. Shivanna KR and Johri BM (1985)The Angiosperm Pollen: Structure and Function. New Delhi, India: Wiley-Eastern.

Paper code: MSB-303
Paper title: Plant Ecology

Course outcome

CO1. **(0.2)** Understanding the nature of ecosystem, food chain, food web, biosphere, biogeochemical cycles.

CO2. **(0.1)**To get detail knowledge about population ecology

CO3. **(0.1)**To get detail knowledge about concept of community, concept of climax, ecological succession.

CO4. **(0.2)**Understanding the cause, effects of environmental pollution.

CO5. **(0.2)**Detail knowledge about plant diversity, loss of diversity, indigenous medicinal system. Biosphere reserve, protected areas of India.

CO6. **(0.2)** Strategies for conservation of plant diversity, seed bank, activities of BSI, sustainable development

Course Content: **Credit: 4**

Unit I:
Introduction to ecology, Nature of ecosystem, Food chains in Ecosystems, Food webs, Ecological pyramids, Energy flow, Biogeochemical Cycles (global) of C, N, P and S, The biosphere, biomes and impact of climate on biomes.

Unit II:
Population Ecology: Characteristics of population, population growth curves, Population size and density, Spatial distribution, Age structure, Natality, Mortality, Biotic potential;life history strategies (r and k selection) Population dynamics, Competition and coexistence, Intra-specific interactions, interspecific interactions, Mutualism and commensalism, Prey-predator interactions, Scramble and contest competition.

Unit III:
Vegetation organization: Concepts of community, Species Diversity and Pattern Diversity in Community, Ecological succession: Trends of succession, Types and general process of succession, Concept of climax, Community evolution.

Unit IV:
Environmental pollution: Origin of pollution, Types of pollutants, Kinds of sources of air, soil and water pollution, Parameters to assess the pollution level, Effects of pollution on plants and ecosystems and pollution abatement.

Unit V:
Plant diversity: Concept, status in India, utilization and concerns, Loss of diversity and causes, Indigenous medicinal systems, Strategies for conservation - in situ conservation: International efforts and Indian initiatives, protected areas in India -sanctuaries, national parks, Biosphere reserves.
Strategies for conservation - ex situ conservation: Principles and practices, botanical gardens. Field gene banks, Seed banks, in vitro repositories, cryobanks, general account of the activities of Botanical Survey of India (BSI), Sustainable development.

Suggested books:

1. Concept of ecology. Kormondy
2. Ecology-concept & application. M.C Molles
3. Ecology-Theories & application. P.Stiling
4. Fundamental of ecology. E.P Odum
5. Ecology. C.Merchant
6. Plant ecology. R.S Shukla & P.S Chanda
7. Cunningham, W.P. and Saigo, B.W. 1999. Environmental Science. WCB, McGraw Hill
8. Hunter, M.L. 1996. Fundamentals of Conservation Biology. Blackwell Science, Oxford.
9. Jones, A.M. 1997. Environmental Biology. Routledge Publications, London and New
10. Mooney, H.A. and Gordon, M. 1983. Disturbance and Ecosystems components of Response. Springer Verlag. Berlin Heidelberg, New York, Tokyo.

Paper code: MSB-304
Practical V
Paper title: Microbiology, Plant Pathology, Biotechnology and Developmental Biology

Course outcome:

CO1. **(0.2)** To learn about preparation and sterilization of various microbial culture media and inoculation.
CO2. **(0.2)**To get knowledge about how to identify various plant diseases, isolation and study of the pathogens and how to make disease herbarium sheet/ report.

CO3. **(0.2)**To get knowledge about differential staining of bacteria using Gram stain.

CO4. **(0.2)** Prepare a plant extract and perform TLC

CO5. **(0.1)**Techiques to study pollen morphology and how to develop hydroponic cuture

CO6. **(0.1)** To get knowledge about study of Microsporogenesis and Megasporogenesis

Course Content: **Credit-4**

Unit I:
1. Make suitable micropreparations and identify the diseases mentioned with due emphasis on symptoms and causative organisms.
2. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method.
3. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.
4. Preparation and sterilization of various microbial culture media and inoculation.
5. Differential staining of bacteria using Gram stain.

Unit II:
1. Estimate the concentration of the given sample using colorimeter or spectrophotometer.
2. Prepare a plant extract and perform TLC.
3. Study of the morphology of the pollen.
4. Micropropagation of important crops.
5. Experiment on Hydroponics
6. A study of Microsporogenesis and Megasporogenesis with the help of permanent slides.

Suggested Books:

1. Modern Practical Botany, S. Chand. Vol-III, 2010, By B. P. Pandey
2. A text book of practical Botany Vol. III, 7th Ed. (2004), Rastogi publication, Ashok M. Bendre, Ashok Kumar.

Paper code: MSB-305
Practical VI
Paper title: Plant Ecology

CO1. **(0.2)** To learn about qualitative aspects of field ecology

CO2. **(0.2)** To learn about qualitative aspects of aquatic ecology

CO3. **(0.2)** To learn about quantitative aspects of field ecology

CO4. **(0.2)** To learn about quantitative aspects of aquatic ecology

CO5. **(0.2)**Hand on training of various ecological instruments and visit to different research institute/University

Course Content: **Credit-4**

Unit I:

1. To determine minimum size and number of quadrat required for reliable estimate of biomass in grasslands.
2. To compare protected and unprotected grassland stands using community coefficients (similarity indices).
3. To estimate IVI of the species in a grassland/woodland using quadrat method.
4. To determine gross and net phytoplankton productivity by light and dark bottle method.
5. Analysis of edaphic characteristics-soil profile, texture, soil moisture, water holding capacity, porosity, pH, organic matter content, quantitive estimationof N, P, K .
6. Analysis of physcio –chemical and biological characteristics from polluted and unpolluted water bodies: DO, COD, BOD, pH. Hardness, alkalinity, conductivity, free CO_2, chloride, nitrate and phosphate.
6. Calibrate the pH meter and test the pH of different sample solutions.

Unit II: Field study

A: i) Study of different

a) Vegetation types

b) Land use pattern

ii) Collection of different plant specimen

iii) Preservation and Identification of specimen

B: Visit to different research institute/University

Paper code: MSB-306

DSE-I

Paper title: Bio fertilizer and organic farming

Course outcome:

CO1. **(0.2)**To get the knowledge of different microorganism involve in improving soil health .

CO2. **(0.2)** It will also give the knowledge of organic farming.

CO3. **(0.2)** Students will learn different techniques to produce biofertilizer

CO4. **(0.2)** Students will learn about the methods of isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

CO5. (0.2) Students will get detail knowledge about organic farming, animal husbandry, homemade fertilizer.

Course Content: **Credit-4**

Unit I

Bio fertilizer: Introduction , Concept, Production, Advantages ,Disadvantages, Benefit over chemical fertilizers, Types and their application : Rhizobium, Azotobacter, Azospirillum, Cynobacter, Azolla, Phosphate solubilising micro organism(PSM), AM fungi, Silicate solubilising bacteria (SSB), Plant growth promoting bacteria (PGPR).

Unit II

Mode of action of bio fertilizer, Liquid bio fertilizers: Characteristic, benefits, application, methodology of application: Seed treatment; Root dipping, Soil application, Doses of liquid bio fertilizer in different crops, Mass production of bio fertilizer, Constrains in bio fertilizer technology, Cost and availability of bio fertilizer, Economic.

Unit III

Introduction to organic farming, Need for organic farming, Characteristic of organic farming, Growth of organic agriculture, Types of Organic farming: Vermicompost, green leaf manure, Crop rotation, Biological management, Animal husbandry, bio fertilizers, manures,

Unit IV

Environmental benefit for organic agriculture, homemade fertilizer, production of organic fertilizers, Compost making process, certified organic, role in agriculture.

Semester IV

Paper code: MSB-401
Paper title: Biostatistics, Computer application and Bioinformatics

Course outcome:

CO1. **(0.2)** To understand the importance and scope of statistical methods in experiments.

CO2. **(0.2)**To learn various statistical methods, formulas to analyze different experiments as well as principles of designs of experiments.

CO3. **(0.1)**To get the basic knowledge of types and components of computer

CO4. **(0.1)**To learn about computer application for preparation of manuscripts, drawings, graphs, charts histograms.

CO5. **(0.2)** Understand bioinformatics, biological database, Sequence analysis and comparison

CO6. **(0.2)** Learn about Digital computer, Needle man – Wuncle and Smith-Wateman algorithm.

Drug design – history; analog design; in-silico drug design.

Course Content:

Credit: 4

Unit I:

Importance and scope of statistical methods in experiment. Mean, median, mode, standard deviation, standard error, variance, co-efficient of variation.

Probability distributions; sampling of data, random and non-random sampling; test of hypothesis.T-test, *chi*- square test, F- test of hypothesis.Analysis of variance, correlation and regression analysis. Goodness of fit.

Principles of design of experiments.

Unit II:

Definition, history, types of computers. Application of computer, basic components of computer.

Organization of digital computers- input devices, processing units.

Computer memory, primary memory, secondary memory, computer peripherals.Output devices.

Computers for preparation of manuscripts, drawings, graphs, charts, histograms.

Unit –III

Introduction to Bioinformatics; Scope and application.

Database; biological database - sequence and structural database (NCBI, PDB, Swiss Prot, KEGG and EBL).

Sequence analysis and comparison; Similarity and homology between sequences; sequence alignment – pair wise and multiple sequence alignment (BLAST, FASTA, Clustal W; phylogenetic relationship and EMBOSS).

Unit-IV

Digital computer – structural organization; operating system (DOS & Linux); Concept of languages of different levels.

Needle man – Wuncle and Smith-Wateman algorithm.

Drug design – history; analog design; in-silico drug design

Suggested books:

1.JH Zar (1999). Biostatistical Analyses. Dorling Kindersley (India Pvt Ltd), New Delhi.

John Townend (2002). Practical statistics for Environmental and Biological Scientists. John Wiley & Sons Ltd., Baffins Lane, Chichester, England.

Bajapai PK (2006). Biological Instrumentation and Methodology, New Delhi, S chand and co Ltd.

SS Rao and J Richard (2010). Introduction to Biostatistics and Research Methods.

Khan IA and Khanum A, Fundamentals of Biostatistics, 1994, 1st edition, Ukaaz

publishers
Keen RE and Spain JD, 1992, Computer simulation in biology a basic introduction: John Wiley & Sons private Lmtd.
Medhi J, 1992, Statistical methods, Willey eastern Limited. Attwood TK and Parry-Smith
DJ (2004) Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press,New Jersey, USA.

Paper code: MSB-402
Paper title: Special paper

***Any one of the following
A. Genetics and plant breeding
B. Biochemistry and Plant Physiology
C. Angiosperm taxonomy
D. Plant ecology
E. Microbiology
F. Mycology and Plant Pathology
(N.B.: * details have been given below)**

Paper code: MSB-402A
Paper title: Genetics and plant breeding

Course outcome:

CO1. **(0.2)** To understand the gene expression and regulation in Prokaryotes & Eukaryotes.

CO2. **(0.2)**To gain better knowledge in both Prokaryotes & Eukaryotes about the Gene Mutation, Repair Mechanisms, Nuclear Genome Organization, Genes and gene numbers.

CO3. **(0.2)** Comprehensive and detailed analysis of fine structure of the gene.

CO4. **(0.2)** Analyze the role of transposable elements in prokaryotes and eukaryotes.

CO5. **(0.2)**Insight into the manipulation of genetic material for a wide variety of purposes and products via Recombinant DNA Technology.

Course Content:

Credit: 4

Unit 1 Molecular genetics

Regulation of cell cycle; Independent assortment and crossing over; Genetic recombination, molecular mechanism of recombination; Gene Structure and expression: Genetic fine structure; RNA splicing; Regulation of gene expression in prokaryotes and eukaryotes;

Unit 2 Mutation

Spontaneous and induced mutations, physical and chemical mutagens, molecular basis of gene mutation; DNA damage and repair mechanisms, inherited diseases and defects in DNA repair, protooncogenes and oncogenes;

Unit 3 Origin and history of crop plants:

Plant domestication - morphological, agronomic and genetic features accompanying domestication of plants, agro-biodiversity, genetic erosion.

Unit 4 Plant genome and crop improvement:

Cytogenetics and its role in evolution and improvement of crops such as wheat, cotton, *Brassica* etc.; location and mapping of genes on chromosomes, molecular cytogenetics. Genome analysis – modern approaches, biochemical and molecular tools for the analysis of plant genome including protein and DNA based techniques; structural and functional genomics in relation to crop improvement.

Unit 5 Population genetics and breeding methods

Genetic composition of cross-pollinated population: introduction, the hardy weinberg law, factors distributing the equilibrium in population, systems of mating; Back cross method: requirements of back cross programme, genetic consequences of repeated back crossing, selection of parents, procedure, application, merits, demerits and achievements;Release of new varieties.

Suggested books:

1. Lehninger Principle of Biochemistry (2004). MichealM.Cox and David L. Nelson.4th Edition, W.H., Freeman and Company, New York, USA.
2. Molecular biology of the gene (2008). James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gam, Michel Levine, Richard Losick. 5th Edition, Pearson Education Inc and Dorling Kindersley Publishing.
3. Molecular biology of the cell (2008). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. 5th Edition, Garland Science Publisher.
4. Genomes 3 (2006). T. A. Brown. Garland Science Publisher.
5. Essential genetics: A genomics perspective (2011). Daniel L. Hartt. Jones and Bartlett Publisher.
6. Transcriptional regulation in eukaryotes concepts strategies and techniques (2009). Michel F. Carey, Craig L. Peterson and Stephen T. Smale. 2nd Edition, Cold Spring Harbour Laboratory Press.

7. Cell and Moleccular biology (2011). E.D.P. De Robertis and E. M.F. De Robertis, Jr. 8th Edition, Wolters Kluwer (India) Pvt. Ltd.
8. Molecular biology principles and applications of Recombinant DNA (2001). Bernard R. Glick, Jack J. Pasternak, 2nd Edition, ASM Press, Washington.
9. Genes IX (2006). Benjamin Lewin. Jones and Bartlett Publishers.
10. Essentials of molecular biology (1993). David Freifelder and George M. Malacinski. 2nd Edition, Jones and Bartlett Publishers.
11. Sambrook J and Russell DW (2001). Molecular Cloning – A Laboratory Manual, Vols I – III,Cold Spring Harbor Laboratory, USA.
12. Singer M and Berg P (1991). Genes and Genomes: A Changing Perspective; University Science Books, CA, USA
13. Herman EB (2008) Media and Techniques for Growth, Regeneration and Storage 2005-2008. Agritech Publications, New York, USA.
14. Raghavan V (1997) Molecular Embryology of Flowering Plants, Cambridge Univ. Press.
15. Raghavan V (2000) Developmental Biology of Flowering Plants, Springer Verlag, NewYork.
16. Shivanna KR and Johri BM (1985)The Angiosperm Pollen: Structure and Function. New Delhi, India: Wiley-Eastern.

Paper code: MSB-402B
Paper title: Biochemistry and Plant Physiology

Course outcome:

CO1. **(0.2)**Understand the basic knowledge about atoms, molecules and bonds, various stabilizing reactions. Structure and properties of pH, buffers

CO2. **(0.2)**Detail knowledge about bioenergetics, laws of thermodynamics.

CO3. (0.2)Detail knowledge about carbohydrate metabolism and lipid metabolism.

CO4. (0.2)Understanding the enzyme biochemistry

CO5. (0.2) To learn about the physiological effects of various biotic and abiotic stress**.** Responses of plants to biotic (pathogen and insects) and abiotic (water, drought, salinity, temperature and global warming) stresses.

Course Content: **Credit: 4**

Unit 1:

Atoms and Chemical bond: Structure of atoms, molecules and chemical bonds. Stabilizing interactions (Van der Walls, electrostatic, hydrogen bonding, hydrophobic interactions, etc.). Structure and properties of pH, buffers.

Unit 2:

Bioenergetics: Concept of free energy. Laws of thermodynamics, enthalpy, entropy, coupled reactions, redox potentials, high energy bonds, ATP and its significance. Biological energy transducers.

Unit 3:

Carbohydrate metabolism: Biosynthesis of carbohydrate and their regulation. Catabolism of glucose, glycolysis, TCA- cycle, oxidative phosphorelation, electron transport chain, ATP formation. **Lipid metabolism:** Biosynthesis of fatty acids and its regulation. Fatty acid oxidation. Biosynthesis of amino acids, Glyoxylate cycle.

Unit 4:

Enzymes: Nomenclature and classification. Mechanism of Enzyme action. Kinetics of unisubstrate enzyme catalyzed reactions. Derivation of different plots from Michelis-Menton equation. Allosteric enzymes, kinetics of Allosteric enzymes. Enzyme immobilization.

Unit 5:

Stress physiology: Water stress, drought, frost, salinity and global warming. Mechanism of plant responses to water and related stresses. Responses of plants to biotic (pathogen and insects) and abiotic (water, drought, salinity, temperature and global warming) stresses.

Code: MSB-402C
Paper title: Angiosperm Taxonomy

Course outcome:

CO1. **(0.2)** Understand the basic idea of flowering plants and their systematic position or classification.

CO2. **(0.2)**Students may visit the forest area for collection of plants and identify with upto their knowledge learnt at the class

CO3. **(0.2)**Students may know the uses of unknown plants used by the tribal people of the soeity with ethnobotanical uses.

CO4. **(0.2)**Students may visit some research organsaions like BSI, NBRI, FRI and can gather knowledge about the herbarium technique with up to date nomenclature of the plant

CO5. **(0.2)**They can apply for Research fellowship for Ph. D and other higher Degree in Plant Taxonomy in Universities and Deem Universities for their future employment.

Course Content: **Credit: 4**

Unit I:

Different systems of classification-artificial, natural, phylogenetic, Linnaeus, Bentham & Hooker, Conqruist, Taktajan's systems.

Scientific naming of plants: the nomenclature, rules & principles, effective & valid publications, different kinds of Types species.

Unit II:
Botanical survey of India, Its organization, Activities and Publications.
Botanical library, Uses of Botanical library, Botanical library as a training centre, Major Botanical library in the world, Botanical garden, Important botanical gardens of India and abroad, Herbarium – Kinds and functions of herbaria, role of herbaria in teaching and research, important herbaria of India and abroad.

Unit III:
Modern trends in Taxonomy, External morphology, Vegetative anatomy, Cytology, Palynology, Numerical Taxonomy, Chemotaxonomy, Serotaxonomy.

Different theories of Origin and evolutionary trends in angiosperms, Stamen-95 Evolution and Nature, carpel polymorphism, Phyllodethery, Telome theory.

Unit IV:
Forest types and forest flora of NE India, Endemic and exotic elements in the flora of India with special reference to NE India, Conservation of endangered plants and habitats.

Unit V:
Distinguishing characters systematic and phylogeny,
Economic importance of Dicotyledonous orders---Magnoliales, Ranunculaes, Scrophuriales, Lamiales, Caryophyllales, Leguminales, Asterales.
Economic importance of Monocotyledonous orders---Alisinatales, Arales, Poales, Cyperales, Zingiberales, Orchidales.

Suggested books:

1. Taxnomy of Botany , Angiosperm, B.P. Pandey, S. Cand, (2012)
2. Taxonomy of Angiosperm, B.P. Pandey, S. Cand, (2012)
3. Taxonomy of Angioperm, 2nd Ed.(2012), Rastogi publ, V. Singh
4. Embryology of Angiosperm by S.S Bhojwani and S. P. Batnagar, Vikash Publ. (1992)
5. Modern Plant Taxonomy, N. S. Subrahmanyam, Vikas Publishing House Pvt. Ltd., 2nd Ed. 2001
6. Degree Botany , Part -II,2009 By Bhabananda Barua, Kalayni Publishers, 2009

Paper code: MSB-402D
Paper title: Plant Ecology

Course outcome:
CO1. **(0.2)**Detail knowledge on the environment, its types, concept of habitat and niche.

CO2. **(0.2)**Detail knowledge on population ecology

CO3. **(0.2)**Detail knowledge on community ecology

CO4. **(0.2)** Detail knowledge on ecosystem ecology and ecological succession.

CO5. **(0.2)**Detail knowledge on mineral cycling

Course Content: **Credit: 4**

Unit I:

Ecosystem function: Productivity of Ecosystems: Primary productivity, Secondary productivity and Net productivity; Primary productivity of terrestrial and aquatic ecosystems of the world.

Energy Flow in Ecosystems: Single channel energy model, Y-shaped energy flow model

Biogeochemical cycle with particular reference to cycling nitrogen

Ecosystem dynamics: development of ecosystem. Ecosystem stability-ecosystem resistance and resilience.

Unit II:

Community Ecology: characteristics of community: Species diversity, Growth form & structure, Dominance, Succession, Trophic structure, Composition of community, Analytical characters.

Methods of study of community: Floristic methods, Physiognomic methods, Phytosociological methods.

Habitat & Niche, Ecotone& Edge effect, Ecological indicator

Unit III:

Phytogeography: Phytogeographic regions of India.

Plant migration and barrier of plant distribution, Endemism.

Climate change: greenhouse gases (CO_2, CH_4, N_2O, CFCs: sources, trends and role), ozone depletion and consequences of climate change.

Unit IV:

Biological diversity: Distribution and global patterns; Biodiversity hotspots.Speciation and extinction; IUCN categories of threatened species; Sustainable utilization of biodiversity; Plant diversity conservation in India.

Unit V:

Ecology and Human Welfare:Human impacts on natural ecosystems - forest, grassland and mountain ecosystems.

Soil erosion and its control; Shifting cultivation and its ecological implications

Coal mining and other environmental problems of northeast India.

Ecorestoration of degraded ecosystems; environmental impact assessment (EIA).

Suggested reading:

1. P.D. Sharma, 2012, Ecology and Environment. Rastogi Publications, India
2. Edward J. Kormondy, 2007, Concept of Ecology. Prentce Hall of India, New Delhi
3. H.M. Saxena, 2006. Environmental Studies. Rawat Publications, India
4. BegonM.Harper J.L. and Townsend C. R. (1990). Ecology: Individual, Populations and Communities. Blackwell Scientific Publisher.
5. Odum E. P. (1971). Fundamentals of Ecology. W. B. Saunders.
6. Odum E. P. (1983). Basic Ecology. Holt Saunders International.
7. Daubernmire R. (1974). Plants and environment. John Wiley & Sons.

8. Hanson H. C. and Churchill E. D. (1963). Plant Communities. Reinhold.
9. Cunningham, W.P. and Saigo, B.W. 1999. Environmental Science. WCB, McGraw Hill
10. Hunter, M.L. 1996. Fundamentals of Conservation Biology. Blackwell Science, Oxford

Paper code: MSB-402E
Paper title: Microbiology

Course outcome:

CO1. **(0.2)** Understanding microbial taxonomy and diversity, classification, microbial photosysthesis, chemosynthesis, microbial respiration

CO2. **(0.2)** Detail knowledge about soil, air and water microbiology

CO3. **(0.2)**Genetic recombination in bacteria.

CO4. **(0.2)**Detail knowledge on mutation in bacteria.

CO5. **(0.2)**Detail knowledge on recombinant DNA technology

Course Content: **Credit: 4**

Unit I:

Microbial Taxonomy and Diversity: Bacteria, Archea and their broad classification; Eukaryotic microbes: Yeasts, molds and protozoa; Viruses and their classification; Molecular approaches to microbial taxonomy.

Unit II:

Microbial Growth: Definition of growth; Growth curve; Mathematical expression of exponential growth phase; Measurement of growth and growth yields; Synchronous growth; Continuous culture; Effect of environmental factors on growth. Control of Micro-organisms: Effect of physical and chemical agents; Evaluation of effectiveness of antimicrobial agents.

Unit III:

Microbial Metabolism: Energetics: redox reactions and electron carriers; An overview of metabolism; Glycolysis; Pentose-phosphate pathway; Entner-Doudoroff pathway; Glyoxalate pathway; The citric acid cycle; Fermentation; Aerobic and anaerobic respiration; Chemolithotrophy; Photosynthesis; Calvin cycle; Biosynthetic pathway for fatty acids synthesis; Common regulatory mechanisms in synthesis of amino acids; Regulation of major metabolic pathways.

Unit IV:

Microbial Diseases and Host Pathogen Interaction: Normal microbiota; Classification of infectious diseases; Reservoirs of infection; Nosocomial infection; Emerging infectious diseases; Mechanism of microbial pathogenicity; Nonspecific defense of host; Antigens and antibodies; Humoral and cell mediated immunity; Vaccines; Immune deficiency; Human diseases caused by viruses, bacteria, and pathogenic

fungi.Chemotherapy/Antibiotics: General characteristics of antimicrobial drugs; Antibiotics: Classification, mode of action and resistance; Antifungal and antiviral drugs. Plant defense mechanism.

Unit V:

Microbial Genetics: Types of mutation; UV and chemical mutagens; Selection of mutants; Ames test for mutagenesis; Bacterial genetic system: transformation, conjugation, transduction, recombination, plasmids, transposons; DNA repair; Regulation of gene expression: repression and induction; Operon model; Bacterial genome with special reference to *E.coli;* Phage λ and its life cycle; RNA phages; RNA viruses; Retroviruses; Basic concept of microbial genomics.

Unit VI

Microbial Ecology: Microbial interactions; Carbon, sulphur and nitrogen cycles; Soil microorganisms associated with vascular plants.

Soil microbiology Soil structure and function, Distribution of microbiology and distribution of microbes, factors affecting distribution of microbes, N2 fixation, organic matter degradation,bacteriocins, Mycorrhizae and Mycorhizosphere.Role of microbes in Agriculture, PGPRS.

Air microbiology: Phyllosphere and phylloplane, distribution of microbes in Air, allergic disorders by air microflora, sampling techniques, composition and conc of air spores.

Water microbiology: Microbial components of water,bacteriological analysis of water, Role and importance of aquatic microbial system.

Suggested readings:

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, McGraw Hill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
3. Microbiology: Principles and Explorations by Jacquelyn Black
4. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis
5. Microbiology by Michael J Pelczar
6. Fundamental Principles Of Bacteriology A J Salle
7. General Microbiology by Power and Daginawala, Himalaya Publishing House,
8. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. science
9. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case, Dorling
Kindersley (india) Pvt Ltd
11. Microbiology by Stuart Walker, W B Saunders

Paper code: MSB-402F
Paper title: Mycology and Plant Pathology

Course outcome:

CO1. **(0.2)**Understand history of Mycology, Fungal cell structure and classification, phylogenetic relation. CO2. **(0.2)**Morphology and reproduction and diversity of spores of few important fugal genera.

CO3. **(0.2)**Understanding fungal physiology, nutritional specialization, secondary metabolites in fungus, mycotoxins.

CO4. **(0.2)** To get knowledge about fungal ecology.

CO5. **(0.2)** To get knowledge about fungal biotechnology.

Course Content: **Credit: 4**

Unit I:

History and development of mycology, cellular organisation of fungi, Different groups of fungi, Identification and classification of fungi, Holomorph concept, ICBN rules, Scope of plant pathology.

Unit II:

Fungal reproduction, different mode of reproduction in fungi, reproduction structure, fungal physiology, growth, nutrition, development, nutritional specialization in parasitic fungi. Epidemiology and disease forecasting, Effects of environmental factors on epidemiology, control of plant diseases, chemical and biological diseases control, integrated disease management (IDM), IDM in important crops.

Unit III:

Ecology of fungi, Fungi of terrestrial and aquatic environment, Economic importance of fungi,Fungal biotechnology, Edible and poisonous mushrooms, cultivation and economic importance of mushrooms, Diseases and changes in plant physiological fuction, Fungi as pollution indicator and its role in detoxification.

Unit IV:

The concept of disease in plants, history of plant pathology, Scope of plant pathology, symptom of plant diseases, Koch's postulate and germ theory of diseases, parasitism and diseases disease development , Dissemination of pathogens, Genetics of plant diseases, Host parasitic interaction, Disease resistance, Post harvest fungal diseases of fruit and vegetable and their management, Biological control of plant disease. Mycorrhiza and wood rotting fungi, defence mechanism in plants, Quarantine and seed certification.

Unit V:

a) Cereals: Rice: Blast disease, sheath blight. Wheat: Loose and Karnal bunt, Rye :Ergot

b) Pulses and Oil Seeds Pigeon pea : Wilt , Chick pea : Blight

c) Oil seeds : Rust of groundnut, sunflower, linseed Coconut : Bud rot

d). Fruits: Grapes: Downy and Powdery mildews, Mango: Anthracnose,Citrus : Canker Gummosis, root and dry rot, Banana: Bunchy top

e) Vegetables: Cucurbits : Powdery mildews, Tomato and Brinjal : Leaf spots, Cabbage and Crucifers : Club root, Chilli : Die-back

f) Cash crops: Sugarcane: Whip smut, Cotton; Wilt and Black arm, Tobacco: Damping off and black shank, Mosaic, Turmeric : Leaf spot

g) Plantation crops: Coffee: Rust Tea: Blister blight; Rubber; Stem rot

Suggested Readings:

1. Tarr, S.A.J . 1987. *Principles of Plant Pathology*. Academic Press.
2. Mehrotra, R.S. 1991. *Plant Pathology*. Tata Megrew – Hill PublishingCompany Ltd.
3. Agrios, G.N. 1999. *Plant Pathology*. Academic Press.
4. Chandanwala, K. 1986. *Introduction to Plant Pathology*. AmmolPublishers and Distributors
5. *Annual Review of Phytopathology*, 1999. Vol. 37, APS Press.
6. Dennis Allsopp and Seal, K.J. 1986. *Introduction to Biodeterioration*. E Edward Arnold (Publishers) Ltd.
7. Frisvad, J.C. Bridge, P.D. and Arora, D.K. 1998. *Chemical fungal taxonomy* Marcel and Dekker Inc.
8. Horsfall, J.G. & Cowelling, E.B. 1978. Plant Diseases – *An Advance Treatise* Vol. II and IV. Academic Press.
9. *Plant Biotechnology*. Tata Mcgraw –Hill Publishsing Company Ltd.
10. Mahadevan, A. 1991. *Post infectional defense mechanisms*. Today and Tomorrow's Printers and publishers.
11. Miles, P.G. and Chang, S.T. 1997. *Mushroom Biology*. World Scientific Publ.Company
12. Natish, S. Chopra, V.L. & Ramachandra, S. 1994. *Biotechnology in Agriculture*. Oxford and IBH Publishing Company.
13. Roberts, S. Fritz & Elien. I. Simms. 1992. *Plant Resistance to Herbivors and Pathogens* (Ecology, Evolutin and Genetics), University of ChicagoPress.

14. Rudra P. Singh, Uma S. Singh & Keiisuke Kohmoto (eds.) 1995.*Pathogenesis and host specificity in plant diseases.* Vol. III PergamonPress.
15. Scheffer, R.P. 199. *The nature of disease in pla*nts. Cambridge University Press.

Paper code: MSB-403A
Paper title: Genetics and plant breeding

Course outcome:

CO1. **(0.2)**Genetics has always been concerned with the problem of how the hereditary information in DNA controls what an organism looks like and how it works.

CO2. **(0.2)** Scientists and doctors hope to use our *genetic* information to diagnose, treat, prevent and cure many illnesses

CO3. **(0.2)**A number of graduate students can be involved in responsible positions with academic & research institutions.

CO4. **(0.2)**Plant breeding is one of our most important weapons in this race by which one can create disease resistant varieties through selection and modern breeding methods.

CO5. **(0.2)**A trained graduate teacher in molecular, genetics and plant tissue culture can be involved in government and private companies that are associated with molecular to cultivar development work.

Course Contents: **Credit: 4**

Unit 1: Techniques in molecular genetics
Electrophoresis, restriction digestion, ligation, DNA probe and hybridization, DNA cloning, Vectors, genomic and cDNA library, PCR amplification, nested PCR, forensics and PCR, DNA sequencing, comparative genome analysis, protein analysis, SDS-PAGE, protein purification with chromatographic system, monoclonal antibody and hybridoma Technology, blotting techniques, model organisms in molecular biology.

Unit 2: Principles of Plant Breeding
Principles involved in breeding and maintaining economic crops; alternative approach through hybridization and selection; concepts in improvement of major crop species; historically important methods and new approaches; polyploidy inheritance, male sterility, self-incompatibility, marker assisted breeding (MAS)

Unit 3: Plant transformation techniques
Cloning of plant cells and manipulation of plant genes; *Agrobacterium* mediated gene transfer- biology and molecular basis of *Agrobacterium* mediated plant transformation and its application, direct gene transfer methods.

Unit 4: Quantitative and evolutionary genetics

Polygenic inheritance; QTL mapping using molecular markers, population statistics; heritability; measurement of heritability; Population Genetics: Populations, gene pool, gene frequency; hardy-Weinberg law; the Hardy-Weinberg equilibrium.

Unit 5: Plant Cell, Tissue and Organ Culture:
Micropropagation and clonal propagation. Synthesic seeds; protoplast culture and somatic hybridization; nuclear and cytoplasmic hybrids; somaclonal variation, DNA-microchip in plant tissue culture industry.

Suggested books:

14. Lehninger Principle of Biochemistry (2004). MichealM.Cox and David L. Nelson.4th Edition, W.H., Freeman and Company, New York, USA.
15. Molecular biology of the gene (2008). James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gam, Michel Levine, Richard Losick. 5th Edition, Pearson Education Inc and Dorling Kindersley Publishing.
16. Molecular biology of the cell (2008). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. 5th Edition, Garland Science Publisher.
17. Genomes 3 (2006). T. A. Brown. Garland Science Publisher.
18. Essential genetics: A genomics perspective (2011). Daniel L. Hartt. Jones and Bartlett Publisher.
19. Transcriptional regulation in eukaryotes concepts strategies and techniques (2009). Michel F. Carey, Craig L. Peterson and Stephen T. Smale. 2nd Edition, Cold Spring Harbour Laboratory Press.
20. Cell and Moleccular biology (2011). E.D.P. De Robertis and E. M.F. De Robertis, Jr. 8th Edition, Wolters Kluwer (India) Pvt. Ltd.
21. Molecular biology principles and applications of Recombinant DNA (2001). Bernard R. Glick, Jack J. Pasternak, 2nd Edition, ASM Press, Washington.
22. Genes IX (2006). Benjamin Lewin. Jones and Bartlett Publishers.
23. Essentials of molecular biology (1993). David Freifelder and George M. Malacinski. 2nd Edition, Jones and Bartlett Publishers.
24. Sambrook J and Russell DW (2001). Molecular Cloning – A Laboratory Manual, Vols I – III,Cold Spring Harbor Laboratory, USA.
25. Singer M and Berg P (1991). Genes and Genomes: A Changing Perspective; University Science Books, CA, USA
26. Herman EB (2008) Media and Techniques for Growth, Regeneration and Storage 2005-2008. Agritech Publications, New York, USA.
14. Raghavan V (1997) Molecular Embryology of Flowering Plants, Cambridge Univ. Press.
15. Raghavan V (2000) Developmental Biology of Flowering Plants, Springer Verlag, NewYork.
16. Shivanna KR and Johri BM (1985)The Angiosperm Pollen: Structure and Function. New Delhi, India: Wiley-Eastern.

Paper code: MSB-403B
Paper title: Biochemistry and Plant Physiology

Course outcome:

CO1. **(0.2)** To get knowledge of water relation, ion uptake and transport mechanism of nutrient in plant.

CO2. **(0.2)**To know the different mechanism of photosynthesis and respiration of plant.

CO3. **(0.2)**To know about the plant growth regulator and nitrogen metabolism of plant.

CO4. **(0.2)** To get the knowledge of physiology of flowering and growth and development mechanism of plant.

CO5. **(0.2)**To get the knowledge of dormancy and germination of seed.

Course Content: **Credit: 4**

Unit 1:
Water relations in plants: Unique physico- chemical properties of water, chemical potential and water potential of the plant. Ion uptake, mechanism of individual cells and roots interaction between ions, ion competition, antagonism and synergism. Transport and translocation of ions, solutes and macromolecules from soil, through cells, across membrane, through xylem and phloem, dual action of ATPases/ pumps and modulation of their activity; specialized mechanisms for phosphorous and iron uptake. Mechanism of stomatal transpiration; mechanisms of loading and unloading of photoassimilates.

Unit 2:
Photosynthesis: Mechanism of photosynthesis, pigment protein complexes, mechanism of pigment system function, cyclic and non-cyclic electron flow, photophosphorylation; C_3, C_4 and CAM pathways of carbon fixation. C_2 photorespiratory cycle. Formation of glycolate and its oxidation. Regulation of photorespiration and its significance.

Unit 3:
Plant growth regulators: Auxins, gibberellins, cytokinins, abscisic acid and ethylene- structure, bioassay, mechanism of action and physiological effects.

Unit 4:
Plant growth and development: Kinetics of growth. Photosynthetic rates; efficiencies in crop production, source-sink relationship, seed germination and dormancy. Physiology of flowering- Photoperiodism and vernalization.

Unit 5:
Phytochrome: phytochrome as a photoreceptor. Isolation of phytochrome, distribution and physico- chemical nature of phytochrome. Phytochrome mediated responses. Germination and dormancy: Factors of seed and bud dormancy- Methods of breaking dormancy, germination stimulators and inhibitors. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

Suggested readings:

1.Plant Physiology.-Frank B.Salisbary and Cleon W.Rose
2. Outline of Biochemistry- Eric.E.Conn, Paul K. Stumpf, George Bruening and Roy H.Doi.
3. Lehninger Principle of Biochemistry.-MichealM.Cox and David L. Nelson
4. Biochemistry.-.U.Satyanarayana and U.Chakrapani 5.Biochemistry-LubertStryer
5. Plant Physiology..-.P.S.Gill
6. Plant Physiology..-.RamdaneDris and Catherine Barry-Ryan 8.Texbook of Biochemistry..-Thomas M.Devlin
7. Introduction to Plant Physiology- W. C. Hopkins.
8. PhytochemistryVol.I, II and III- P. Miller.
9. The Plant Physiology- LTaiz. and F. Ziegler.
10. Biochemistry of Plants. A Comprehensive Treatise- P.K. Stump and E. Conn.
11. Phytochrome and Photomorphogenesis- H. Smith.
12. Physiology of Plant Growth and Development- . M. B. Wilkins.
13. Biochemistry-Geoffrey Zubay

Paper: Angiosperm Taxonomy
Paper code: 403C

Course outcome:

CO1. **(0.2)**Studying plant morphology student will be benefitted to identify plants (visual identification) properly when they go for field work for collection of plants for different research works. Proper identification and classification is important in the fields like genetics, ecology, physiology, systematics and evolutionary biology.

CO2. **(0.2)**Taxonomy helps to organize plants into similar groups. So it becomes easier to study and place a new species whenever it is discovered during any research work. It also allows us to identify, group and properly name an organism through a standardized classification system.

CO3. **(0.2)**As Taxonomy is the "Mother of plant science", it helps them to study all the applied disciplines of plant sciences such as Agriculture, Horticulture, Forestry, Pharmacognosy, Biotechnology, etc.

CO4. **(0.2)**By studying plant tissues and cells (anatomy) they will learn how the plants constructed and how they work. These studies are very important because they lead to be a better understanding of how to take care for plants and fight plant diseases.

CO5. **(0.2)** Plant morphology helps to know the different types and forms of leaves, flowers, fruits, seeds, etc., which is an identifying marker for closely related species.

Course Content: **Credit: 4**

Unit I

Plant identification, Taxonomic literature- floras, manuals, monographs, icons, journals, other supporting literature Botanical Keys-sequential keys, multi-access keys, automated pattern recognition systems, web identification Punched Card Keys, Major taxonomic works in India.

Unit II

Importance of plants and plant products, Origin of cultivated plants, plant introduction and plant domestication with references to Vavilove's work, center of origin.

Unit III

Phytogeography: Phytogeographic regions of India. Endemism, hotspot. Endemism in Western Ghats and Indo-Himalayan region. Exotic, invasive, introduced and alien species. Biodiversity assessment of magnitude, use of GPS & GIS, importance conservation & utilization, Forest and forest types of North East Region RET Plants and their conservation with special reference to northeast India.

Unit IV

Study of Monocot families with reference to their systematic position, distinguishing characters, affinity, phylogeny and economic importance: Orchidanceae, Musaceae, Zingiberaceae, Cannaceae, liliacea, araceae, aracaceae, Cyperaceae, Poaceae.

Unit V

Study of Dicot families with reference to their systematic position, distinguishing characters, affinity, phylogeny and economic importance: Ranunculaceae, Magnoloaceae, Nymphyeaceae, Cucurbitaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae.

Suggested books:

1. Nei, M. and S. Kumar 2000. Molecular Evolution and Phylogenetics. Oxford University Press, New York.
2. Simpson, M.G. 2006. Plant Systematics. Elsevier, Amsterdam
3. Stuessy, T.F. 2009. Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York
4. Cliford H.T and W. Stephenson. 1975. An Introduction to Numerical Taxonomy. Academic Press, N.Y.
5. Lawrence G.H.M 1955. An Introduction to Plant Taxonomy N.Y
6. Singh V. and D.K Jain, 1981 Taxonomy of Angiosperms. Rastogi Publication, Meerut
7. Swingle D.B. 1946. A Text book of Systematic Botany. Mc Graw Hill Book Co. New York
8. Pande B.P 1997. Taxonomy of Angiosperms. S. Chand Publication.
9. Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Hafner Publ. Co. New York.
10. Maheshwari, P. 1985. An Introduction to Embryology of Angiosperms. Tata McGraw Hill. New Delhi
11. Subramaniam, N. S. 1995. Modern Plant Taxonomy. Vikas Publishing House. New Delhi

12. Gurcharan Singh, 2004. Plant Systamatics: Theory and Practice. Oxford & Ibh Publishing Co. P. Ltd., New Delhi.

Paper: Plant Ecology
Paper code: 403D

Course outcome:

CO1. **(0.2)**To highlight the students with some basic understandings of conservation ecologyits principles, postulates and ethics. The students will also get an idea of protected area networks and their management, Biodiversity act and biodiversity action plan. Finally students will also learn about some practical case studies on conservation/management strategy in India.

CO2. **(0.2)** Designed to give an understanding of, what is a natural resource, types of resources, natural resources degradation and its conservation. The students will also have an understanding on shifting cultivation, coal mining and also the various environmental problems of northeast India and its ecological implication and also about sustainable development.

CO3. **(0.2)** It has been designed to impart an understanding on global environmental problems such as ozone depletion, global warming, greenhouse effect, different greenhouse gases, acid rain, climate change and its ecological consequences

CO4. **(0.2)** It deals with the understanding of some modern technology used in landscape monitoring and environmental management such as remote sensing and GIS - it's Principles and concept, understanding on image processing techniques and various application of remote sensing and GIS

CO5. **(0.2)** Deals with the understanding of phyto-geographical regions of India,detail idea about the floras of North-East India. Understanding on mechanism of migration and barrier of plant distribution and also about biodiversity hotspots and endemism

Course content: **Credit:4**

Unit –I

Introduction to conservation ecology- principles, postulates and ethics. Protected area networks and their management. Indian case studies on conservation/management strategy. Biodiversity act and biodiversity action plan.

Unit II

Natural resources degradation and conservation: What is a natural resource, Types of resources, Increasing pressure on Natural resources. Soil resource degradation and soil conservation, Shifting cultivation and its ecological implication, Coal mining and environmental problems of northeast India, Sustainable development.

Unit III

Global environmental problems: ozone depletion, formation of ozone, importance, cause of ozone depletion, ecological impact, global warming, consequences of global warming, green

house effect, greenhouse gases (CO_2, CH_4, CFC, N_2O), Acid rain Climate change, causes of climate change.

Unit IV

Remote Sensing and GIS: Principles and concept of remote sensing; introductory image processing techniques; application of remote sensing; GIS technology; applications of GIS in environmental management.

Unit V

Phytogeography and Environmental ecology:

Phytogeographical regions of India, Detail idea about the floras of North-East India.

Plant migration and barrier of plant distribution, Endemism, Biodiversity hotspots.

Suggested books:

1. Concept of ecology.....Kormondy
2. Ecology-concept & application.....M.C Molles
3. Fundamental of ecology.....MC Dash
4. Ecology-Theories & application.....P.Stiling
5. Fundamental of ecology.....E.P Odum
6. Ecology .....C.Merchant
7. Plant ecology.....R.S Shukla P.S Chandal
8. Ecology and Environment.....P.D. Sharma

Paper code: MSB-403E

Paper title: Microbiology

Course outcome:

CO1. **(0.2)**Understanding briefly about industrial microbiology

CO2. **(0.2)** Detail knowledge about microbial fermentation and industrial fermentation

CO3. **(0.1)**Uses of microbes in medicine, biofuel, biopolymer, alcoholic fermentation

CO4. **(0.2)**To get knowledge about microbiology in stress environments

CO5. **(0.2)**Basic knowledge about food microbiology

CO6. **(0.1)**Uses of microbe sin petroleum microbiology

Course Content: **Credit: 4**

Unit I:

Industrial microbiology, Fermentation and fermentable microbes, history and design of fermenters (bioreactors), basic functions of fermenters, types of fermenters construction of fermentors.

Batch fermentations, Feed batch fermentations, continuous fermentations

Culture preservation, methods of preservation

Unit II:

Types of fermentation process, microbial biomass, microbial enzymes, microbial metabolites, and transformation process.

Types of fermentation-solid state fermentation and submerged fermentation, Batch and continuous fermentation

Antibiotic-penicillin; amino acid-lysine; enzyme-amylase; organic acid-citric acid; biofuel-bioethanol; biopolymer-PHB; alcoholic beverage-wine, beer

Unit III:
Microbiology of stress environments (domestic wastes, extreme natural wastes, pesticides and microbes, heavy metals and air pollutants)
Bioremediation of soil, air and water pollutants: Dendroremediation, Rhizoremediation, Microbial remediation, Mycorrhizoremediation and Carbon sequestration.

Unit IV:
Food microbiology: food spoilage, food poisoning, preservation of food.
Milk and milk products, sources of microorganisms in milk, milk classification, cheese production, types of cheese, yoghurt.
Enzyme immobilization, Petroleum microbiology: Introduction, hydrocarbon degrading microorganisms, factors determining hydrocarbon degradation, microorganisms as indicators in prospecting for hydrocarbon deposits, microbial enhanced oil recovery (MOER).

Suggested books:

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, McGraw Hill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
3. Microbiology: Principles and Explorations by Jacquelyn Black
4. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis
5. Microbiology by Michael J Pelczar
6. Fundamental Principles Of Bacteriology A J Salle
7. General Microbiology by Power and Daginawala, Himalaya Publishing House,
8. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. science
9. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case, DorlingKindersley (india) Pvt Ltd
10. Microbiology by Stuart Walker, W B Saunders

Paper Code: MSB-403F
Mycology and Plant Pathology

Course outcome:

CO1. **(0.2)**Understanding symptoms of plant diseases caused by fungi, bacteria, viruses, mycoplasmas and Phytoplasmas

CO2. **(0.2)** Diagnosis and identification of diseases, host pathogen interaction

CO3. **(0.2)**Detail knowledge on epidenmiology and disease management

CO4. **(0.2)**Genetics of plant diseases

CO5. **(0.2)**To get knowledge about Biotechnology and plant diseases.

Course Content: **Credit: 4**

Unit-I:
Plant Pathology its History, Concept of disease, Fungi and other organisms as plant Pathogens, losses incurred due to plant diseases , Symptoms of plant diseases caused by fungi, bacteria and viruses, Mycoplasmas and Phytoplasmas.

Unit-II:
Diagnosis or identification of diseases, Koch's postulate and germ theory of diseases, pathogenesis and host range, stages of development of plant disease and disease cycle, dissemination of plant pathogens-air, water, soil, seeds, insect vectors, nematodes, mites, Pollen, nursery stock, overwintering and over summering of Pathogens. Entry of pathogens into the host: by mechanical force, chemical weapons, enzymatic activities, growth regulators. Defense mechanisms of plants against plant pathogens--preexisting structural and chemical defense, immunization-systemic and acquired resistance, Induced resistance inhibitors (production of phenolic substances), Phytoalexins.

Unit-III:
Epidemiology or epiphytotics, factors of epidemiology, patterns of epidemiology, disease forecasting. indexing Control of plant diseases, chemical and biological control , Integrated Disease Management (IDM) Quarantine Inspection. Changes in host physiology due to diseases (movement of water, permeability of cell membrane, transpiration, photosynthesis, respiration, plant reproduction, growth and transcription and translation).

Unit-IV **:**
Genetics of plant diseases, genes and disease, mechanism of variability, types of plant resistance to pathogens, Genetics of Virulence in pathogens and resistance in host, Enzymes, toxins and growth regulators in plant disease development.

Unit- V:
Symptoms, etiology, epidemiology and control measures and management of some important plant diseases of North East India. Aeromycology and plant diseases, Air sampling techniques., Soil and seed borne diseases, Rhizosphere and Rhizoplane, -Seed pathology.
Biotechnology and plant diseases – resistant gene identification and insertion in suitable host for crop improvement, strategies for development of disease resistance in plants..

Suggested Books:

1. Agrios,.G.N.; Plant Pathology5/e 2005,1997,1988,1978 First print in India 2006, Elsevier Inc.Reprint 2008.
2. Alexopoulos and W.Mims. John Wiley & Sons Inc. New york
3. Bessey,E.A. 1950 Taxonomy of Fungi The blackistone and Co. Philadelphia.
4. Bilgrami, K.S and Dube H.S (1976) A Text of modern Plant pathology Vikash Publishing House PVT. Ltd. New Delhi.
5. Butler,E.J. and Jones,S.G (1949): Plant pathology Mac Milan & Co.London.
6. Gauman E.A (1952):The Fungi: Translated by f.L.Wynd Hafner.New York.
7. Rangaswami, G and Mahadevan (1999) : Diseases of Crop plants in India Prantice Hall, India
8. Webster.J.1970:Introduction to Fungi. Cambridge University Press London.
9. Wolf F.A. and Wolf F.T. 1947 The Fungi. VolI .& vol II John Wiley and Sons Inc. New York

Paper code: MSB-405 (DSE-2)
Paper title: Plant resource utilization and conservation

Course outcome:

CO1. **(0.2)** By studying "Plant resource utilisation" students will learn about different dimensions of plant identification as a resource for self- sustenance, their domestication, commercialization based on the need and induction of modification using modern techniques.

CO2. **(0.2)** They will learn about the utilization of wild plants as it is more limited and how to improve it for the new need and imperatives of mankind.

CO3. **(0.1)** Study of medicinal plants would help them in research and development of newer organic drugs that would help to minimize adverse effect that are usually evident in synthetic and semi-synthetically processed drugs. Thereby proving to be a boon to medical science.

CO4. **(0.2)**They will learn about the different conservation processes like in-situ and ex-situ conservation of plants that are going to be extinct very soon due to biotic, abiotic and anthropogenic causes.

CO5. **(0.2)** Study of plant resource utilisation will enhance their specific knowledge and technological skills in converting the rich bio-resource into economic wealth.

Course Content: **Credit: 4**

Unit I:

Applications of genetic engineering – in genetic studies, agriculture and medicine.
Mutation and its application in crop improvement.
Plant nutrition, biofertilizer, biopesticides.
Bioremediation and Phytoremediation.

Unit II:

Geographical distribution and uses of some important medicinal plants
Origin, evolution, botany, cultivation and uses of
Food, forage and fodder crops,
Fibre crops,
Vegetable oil-yielding crops.

Unit III:

Important fire-wood and timber-yielding plants and non-wood forest products (NWFPs) such as bamboos, rattans.Raw materials for paper making, gums, tannins, dyes, resins and fruits.

Unit IV

Conservation of resources

Principles of conservation, extinction, environmental status of plants on international strategies for conservation.

In situ conservation: International effort and Indian initiatives.

Protected areas in India: Sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity

Strategies for conservation: Ex –situ conservation. Principles and practises.Botanical gardens, field gene banks, in vitro repository, cryobanks, general account of the activities of BSI, NBPGR, ICAR, CSIR and DBT for conservation and non formal conservation efforts.

1. Economic Botany , Pooja
2. Economic Botany, N.K.Patel
3. Studies in Botany-(2005)- S.K. Guna and S.K. Chowdhary, Moulik Library Vol-I
   Economic Botany, Albert F. Hill
4. Economic Botany , B. P. Pandey, S. Chand, 2014, 7th Ed.