Indira Gandhi National Tribal University
Amarkantak (M.P.)

SYLLABI

(Based on CBCS Pattern)

Department of Botany
Faculty of Science

M.Sc. Programme in Botany

(Effective from 2020-2021)

Department of Botany
Faculty of Science
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Course Layout:

Course Components	Paper Code	Paper Title	Credits		
SEMESTER – I			**L**	**T**	**P**
Core Course (CC)	MBT 101	Phycology & Bryology	04		
	MBT 102	Mycology & Plant Pathology	04		
	MBT 103	Pteridophytes, Gymnosperm &Paleobotany	04		
	MBT 104	Instrumentation, Techniques & Biostatistics	04		
	MBP 101	*Laboratory work based on course MBT 101 & 102*			02
	MBP 102	*Laboratory work based on course MBT 103 & 104*			02
Total			**20**		
SEMESTER – II			**L**	**T**	**P**
Core Course (CC)	MBT 201	Plant Systematics	04		
	MBT 202	Microbiology	04		
	MBT 203	Cytogenetics & Plant Breeding	04		
	MBT 204	Plant Ecology & Phytogeography	04		
	MBP 201	*Laboratory work based on course MBT 201 & 202*			02
	MBP 202	*Laboratory work based on course MBT 203& 204*			02
Total			**20**		

Course Components	Paper Code	Paper Title	Credits		
SEMESTER – III			**L**	**T**	**P**
Core Course (CC)	MBT 301	Plant Physiology	04		
	MBT 302	Plant Biochemistry	04		
	MBT 303	Cell & Molecular Biology	04		
	MBT 304	Plant Biotechnology & Bioinformatics	04		
	MBP 301	*Laboratory work based on course MBT 301 & 302*			02
	MBP 302	*Laboratory work based on course MBT 303 & 304*			02
Discipline Specific Elective (Any one)	DMBT01	Plant Conservation &Biometeorology	04		
	DMBT02	Applied Microbiology			
	DMBT03	Climate Change & Environmental Management			
	DMBP01	*Field / lab works based on course DMBT01/DMBT02/DMBT03*			02
Total			**26**		
SEMESTER – IV			**L**	**T**	**P**
Core Course (CC)	MBT 401	Traditional Knowledge, Intellectual Property Right & Entrepreneurship Development	04		
	MBT 402	Bioresourse Utilization	04		
	MBP 401	*Field & lab works based on course MBT 401 & 402*			02
Discipline Specific Elective (Any one)	DMBP05	Dissertation/Project Work	03	01	
# - Excursion			02		
Total			**16**		
Grand Total (Semester I-IV)			**65**	**01**	**16**
			82		

#-The Excursion tour to different parts of the country for phyto-geographical study and observation / collection of plant materials will be undertaken any time in between III & IV Semesters. However, the study report will be evaluated during IV semester.

Core Courses –Botany

1. Phycology & Bryology
2. Mycology & Plant Pathology
3. Pteridophytes, Gymnosperm &Paleobotany
4. Instrumentation, Techniques & Biostatistics
5. Plant Systematics
6. Microbiology
7. Cytogenetics & Plant Breeding
8. Plant Ecology & Phytogeography
9. Plant Physiology
10. Plant Biochemistry
11. Cell & Molecular Biology
12. Plant Biotechnology & Bioinformatics
13. Traditional Knowledge, Intellectual Property Right & Entrepreneurship Development
14. Bio-resource Utilization

Discipline Specific Electives-Botany (Any one)

1. Plant Conservation & Biometeorology
2. Applied Microbiology
3. Climate Change & Environmental Management

MBT 101: PHYCOLOGY & BRYOLOGY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit-I **12h**

Modern concepts of algal classification; distribution of algae in the diverse habitats, life cycle patterns in algae, algal blooms, algal toxins and phyco viruses.

Unit-II **12h**

A brief account of Cyanophyta, Prochlorophyta, Euglenophyta, Charophyta, Xanthophyta, Bacillariophyta and Pyrrophyta.

Unit-III **12h**

A brief account of thallus organization, reproduction, evolutionary tendencies and economic importance of - Chlorophyta, Phaeophyta and Rhodophyta

Unit-IV **12h**

Bryophytes: General account, origin, evolution and significance of heterotrichy in plants, theories on origin and evolution of bryophytes, evolution of sporophyte, fossil bryophytes

Unit-V **12h**

Comparative account of the gametophytes and sporophytes of Hepaticopsida, Anthocerotopsida and Bryopsida, Peristome structure and its significance in the classification of Mosses.

Suggested Readings:

1. Algae: An Introduction to Phycology, CVD Hoek & DG Chapman (1995), Cambridge University Press, Cambridge
2. The Structure and Reproduction in Algae, FE Fritsch (1935, 1948), Vol I & II, Cambridge University Press, Cambridge
3. An Introduction to the Algae, Ian Morris, Hutchinson University Press
4. The Biology of Algae, FE Round (1986) Cambridge University Press, U.K.
5. Introduction to Algae: Structure and Reproduction, Harnold C Bold, Michael J Wynne (1985), 2nd Edition, Prentice-Hall Inc.
6. Phycology, RE Lee (2008) Fourth edition, Cambridge University Press
7. Introduction to Phyclogy, GR South & Alan Whittick (1998) Blackwell Scientific Publication
8. Biology of Rhodophyta, R Dixon, Koelt Science Publisher, West Germany
9. An Introduction to Bryophytes, NS Parihar, Central Book Depot, Allahabad
10. Bryophytes: Morphology, Growth & Differentiation, P Puri,
11. Biology of Bryophytes, RN Chopra, PK Kumara (1988), Wiley Eastern Ltd.
12. Biology of Mosses, DHS Richardson (1981) Blackwell Scientific publications, Oxford.
13. Bryophyta, BR Vashishta, AK Sinha, A Kumar (2003). S Chand & Co. Ltd.
14. Bryophytic Biology, B Goffinet, A J Shaw (2009), second Edn, Cambridge University Press.

MBT 102: MYCOLOGY & PLANT PATHOLOGY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit- I **12h**

A general account of fungi, principles of classification and identification, mode of nutrition.
A brief account of Myxomycotina.
Mastigomycotina: General account with reference to Chytridiales, Blastocladiales, Saprolegniales and Pernosporales, hormonal regulation of sexuality in Mastigomycotina.

Unit-II **12h**

A general account of Zygomycotina
Ascomycotina: Thallus structure, spore producing organs and life cycle pattern with reference to Endomycetales, Protomycetales, Taphrinales, Eurotiales, Erysiphales, Sphaeriales and Pezizales

Unit-III **12h**

Basidiomycotina: General account with reference to Uredinales, Ustilaginales, Lycoperdales, Phallales, Agaricales, Aphyllophorales, Auriculariales, Lycoperdales and Nidulariales

Deuteromycotina: General account with reference toSphaeropsidales, Melanconiales, Moniliales and mycelia sterilia

Unit-IV **12h**

Defense mechanisms of plants against infection: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds

Unit-V **12h**

Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism
Symptoms, causal organisms, disease cycle and control measures of some of the important diseases of Sal and Teak.

Recommended Books:

1. Introductory Mycology, C. J. Alexopoulos, C.W. Mims, M Blackwell (1996), John Wiley & Sons.
2. The Fungi: An Advanced Treatise, GC Ainsworth, KF Sparrow, AS Sussman.
3. An Introduction to Fungi, H. C. Dube (1983), Vikas Publ, New Delhi.
4. The Fungi, PD Sharma (2003), Rastogi Publications, Meerut
5. Fungi: Experimental Methods in Biology, R Maheshwari (2012), CRC Press, Boka Raton, Florida
6. Introduction to Fungi, J Webster & WS Roland (2007), Cambridge University Press.
7. A Text Book of Modern Plant Pathology, K S Bilgrami, H C Dube.
8. Plant Pathology, RS Mehrotra.
9. Fungi and Plant Disease, VK Gupta, TS Paul
10. Diseases of Crop Plants in India, Rangaswamy & Mahadevan.
11. Plant Pathology, GNAgrios (2006), fifth Edn, Elsevier Academic Press.
12. Molecular Plant Pathology, Dickinson CM (2003), Bios Scientific Publisher
13. Plant Pathology: Concepts and Laboratory Exercises, NT Robert, MT Windham, AS Windham (2003), CRC Press.
14. Plant Diseases, RS Singh (2008), Oxford and IBH Publishing Co. Pvt Ltd
15. Principles of Plant Pathology, RS Singh (2008), Oxford and IBH Publishing Co. Pvt Ltd.

MBT 103: PTERIDOPHYTES, GYMNOSPERMS& PALEOBOTANY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit-I **10h**

Pteridophytes: Classification of Pteridophytes, evolution of vascular systems in plants, stellar system, telome concept, apogamy and apospory, heterospory and seed habits in Pteridophytes

Unit - II **16h**

Early vascularplants: Rhyniophyta, Trimerophytophyta, Zosterophylophyta, Lepidodendron, Lyginopteris.
Comparative morphology and anatomy of gametophytes and sporophytes of Psilopsida, Lycopsida, Sphenopsida and Filicopsida

Unit-III **08h**

Gymnosperms: Modern trends in classification of Gymnosperms, evolutionary tendencies among the Gymnosperms, distribution of Gymnosperms in India
General account of Glossopteridaceae and Cycadeoidaceae

Unit-IV **16h**

A comparative study of the vegetative (both morphological and anatomical) and reproductive structures (including mode of reproduction) in Cycadales, Coniferales, Taxales and Gnetales

Unit-V **10h**

Types of fossils, process of fossilization, techniques for studying fossil plants, relative age determination of fossils, and mode of the preservation of fossil plants.

Suggested Readings:

1. The Biology and Morphology of Pteridophytes, N S Parihar (1996), Central Book Depot, Allahabad.
2. Pteridology in the New Millennium, S Chandra, M Srivastava (2003), Kluwar Acad Publishers.
3. Morphology and Evolution of Vascular plants, EM Gifford, AS Foster (1989), third edition, WH Freeman & Co.
4. An Illustrated Fern Flora of West Himalayas (Vol I, II), S PmKhullar (2000), International Book Distributers.
5. An Introduction to Pteridophytes, A Rashid (1976), Vikas Publishing House.
6. Morphology of Pteridophytes, K R Sporne (1982), Hutchinson University Press.
7. Cryptogamic Botany (Vol. II), G Smith (1972), Tata McGraw Hill Publications.
8. The Morphology of Gymnosperme, K R Sporne, B.I. Publications, New Delhi.
9. Gymnosperms, SP Bhatnagar, A Moitra (1996), New Age IntPvt Ltd, New Delhi.
10. Gymnosperm Phylogeny, CE Beck (1995), Bot Rev, 51-176.
11. Gymnosperms, OP Sharma, S Dixit (2002), Pragati Prakashan.
12. Morphology of Gymnosperms. JM Coulter, CJ Chamberlain (1977), University of Chicago Press.
13. Palaeobotany. SN Agashe (1995), Oxford and IBH publishing House.
14. Introduction to Palaeobotany. CR Arnold (1977),McGraw Hill Book Com.

MBT 104: INSTRUMENTATION, TECHNIQUES& BIOSTATISTICS

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit-I **12h**

Microscopy: Bright-field microscope, Dark-field, Phase-contrast, Differential interference contrast, Fluorescence, Transmission and scanning electron microscopy, confocal microscopy

Unit- II **12h**

Chromatography: Thin layer, ion exchange, gel filtration, affinity chromatography, GLC, HPLC.
Spectroscopy: Beer-Lambert's law, molar extinction coefficient and calculation, Absorption spectrum, Colorimeter and UV-Vis Spectrophotometer, Nuclear Magnetic Resonance (NMR). ESI-MS, MALDI- TOF
Application of tracer techniques in biology, radioactive isotopes, autoradiography

Unit-III **12h**

Electrophoresis: Polyacrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis (AGE), native-Page, SDS-PAGE, Isoelectric focusing (IEF), 2D-electrophoresis
Isolation and purification of genomic and plasmid DNA, RNA and proteins
Blotting Technique: Southern, Northern and Western blottings

Unit-IV **12h**

DNA Amplification: PCR, RT-PCR, genome mapping and expression analysis, RFLP, RAPD, AFLP, *In situ* hybridization, FISH, EST, Microarray

Unit-V **12h**

Biostatistics: Hypothesis testing (t-test, Chi-square test), R x C Contingency table, skewness, kurtosis and their measures, Analysis of variance (ANOVA) - One way and two way, post hoc test, correlation, regression.

Suggested Readings:

1. Biotechnology: A Laboratory Course, JM Becker, GA Caldwell, EA Zachgo (1996), Academic Press, Inc, San Diego, California
2. Principles and Techniques of Biochemistry and Molecular Biology, K Wilson, J Walker (1997), Cambridge University Press, Cambridge
3. Molecular Cloning: A Laboratory Manual, J Sambrook, EF Fritsch, T Maiatis (2000), Cold Spring Harbor Laboratory Press, New York
4. Molecular Biotechnology, SB. Primrose (1994), Blackwell Scientific Pub, Oxford.
5. Analysis of Genes and Genomes, RJ Reece (2004), Wiley
6. An Introduction to Practical Biochemistry, DT Plummer, third edition, Tata-McGraw Hill
7. Modern Experimental Biochemistry and Molecular Biology, R Boyer, second edition, Benjamin/Cumin
8. Physical Biochemistry, DM Freifelder, second edition, Freeman Press
9. Analytical Biochemistry, D Holme, J Peck, third edition, Tata McGraw Hill
10. Statistical methods, GW Snedecor, WG Cochran, eigth edition, East-West Press
11. Biomtery, RR Sokal, FJ Rohlf, third edition, Freeman
12. Statistical Methods, SP Gupta (1984), S Chand & Company.
13. Biostatistical Analysis, JH Jarr (2006), Prentice-Hall.

MBP101: Laboratory work based on course MBT 101 & 102

Credit: 02
Maximum Marks: 50

Phycology:
Identification of the following genera:
Cyanophyceae - *Gloeocapsa, Gloeotrichia, Spirulina, Microcystis, Oscillatoria, Lyngbya, Anabaena, Nostoc, Rivularia, Scytonema.*
Chlorophyceae - *Chlamydomonas, Gonium, Eudorina, Pandorina, Volvox,Tetraspora, Ulothrix, Microspora, Ulva, Cladophora, Pithophora.Coleochaete, Chaetophora, Drapernaldia, Drapernaldiopsis, Trentepohlia, Fritschiella, Oedogonium, Bulbochaete, Zygnema, Mougeotia, Sirogonium.Desmedium, Bryopsis, Codium, Caulerpa, Chara, Nitella*
Xanthophyceae - *Vaucheria*
Bacillariophyceae - *Navicula, Pinnularia*
Phaeophyceae–*Ectocarpus,Dictyota, Pediana, Sargassum, Turbinaria*
Rhodophyceac -*Batrachospermum, Gelidium, Amphiroa, Gracilaria, Polysiphonia*

Bryology:
Identification of the following genera (using morphological, anatomical and reproductive features) - *Plagiochasma, Marchantia, Porella, Anthoceros, Sphagnum, Funaria, Polytrichum*

Excursion: Collection of local algae and bryophytes from different habitats

Mycology:
Critical study of the following genera, with help of suitable micro-preparations - *Saprolegnia, Phytophthora, Albugo, Mucor, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Rhizopus, Curvularia, Fusarium, Colletotrichum.Xylaria, Peziza,Puccinia, Termitomyces, Pleurotus, Auricularia, Polyporus, Lycoperdon,Cyathus, Fusarium, Alternaria, Cladosporium, Pestalotia, Graphis, Parmelia, Cladonia, Usnea*

Plant Pathology:
Identification of causal organisms through suitable micro-preparations, identification of the diseases with emphasis on symptoms and causative organisms of diseases of Sal and Teak trees

Field trips: collection and identification of common diseases of tree plants of the region.
Microscopic study of plant-pathogen interactions using stained sections of diseased materials

MBP 102: Laboratory work based on course MBT 103& 104.

Credit: 02
Maximum Marks: 50

Pteridophytes:

1. Morphological and anatomical study of the vegetative and reproductive parts of the following genera, with the help of wholemounts/sections -*Lycopodium,Selaginella, Equisetum, Marsilea, Salvinia, Azolla, Lygodium, Gleichenia, Pteris, Adiantum, Polypodium*etc.
2. Study of fossil Pteridophytes with the help of specimens and permanent slides

Gymnosperms:

1. Morphological and anatomical study (through C.S., RLS & TLS) of vegetative and reproductive parts of following genera – *Cycas, Pinus, Araucaria, Ephedra, Gnetum* etc.
2. Study of fossil gymnosperms through specimens and permanent slides.
3. Field trip to Ghughua Fossil Park to familiarize students with fossil Pteridophytes and Gymnosperms

Instrumentation, Techniques & Biostatistics:

1. Micrometry: Calibrate the ocular micrometer stage micrometer on a light microscope and measurement of the size of an object (e.g., diameter of spore/pollen grains, width of algal filaments)
2. Estimate the concentration of a given sample using calorimeter or spectrophotometer.
3. Prepare a plant extract and perform TLC
4. Calculation of standard deviation and standard error from a given data
5. Test the significance of a given data using t-test, X^2 test, F-test and ANOVA
6. Determination of probability for different types of events.

MBT 201: PLANT SYSTEMATICS & TAXONOMY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit-I **12h**

Taxonomic principles and procedures, botanical nomenclature: binomial system, ICN rules and recommendations, priority, typification, rules of effective and valid publications, retention and rejection of names and epithets; Herbaria: concepts and function

Unit-II **12h**

General outline and comparative study of Hutchinson, Takhtajan, Cronquist and Angiosperm Phylogenic Group (APG) classifications; their merits and demerits

Unit-III **12h**

Taxonomic features, systematic phylogeny and economic importance of following dicot families: Ranunculaceae, Magnoliaceae, Solanaceae, Convolvulaceae, Brassicaceae, Malvaceae, Rosaceae, Fabaceae, Lamiaceae,Asteraceae, Euphorbiaceae, Amaranthaceae, Lentibulariaceae, Droseraceae and Balanophoraceae

Unit-IV **12h**

Taxonomic features, systematic phylogeny and economic importance of following monocot families**:** Orchidaceae, Zingiberaceae, Araceae, Liliaceae, Musaceae, Cyperaceae and Poaceae

Unit-V **12h**

Changing trends in plant taxonomy: Molecular approaches to plant taxonomy: molecular phylogeny, Angiosperm phylogeny groups; Numerical taxonomy; Chemotaxonomy; Embryology in relation to taxonomy, role of cytological data and anatomical characters in taxonomic studies.

Suggested Readings:

1. Principle of Angiospermic Taxonomy, PH Davis, VH Heywood (1991), Today & Tomorrow Publications, New Delhi
2. Fundamentals of Plant Sytematics, AE Radford (1986), Harper & Row Publications, USA.
3. Principles of Plant Taxonomy, VVSivarajan (1999), Oxford & IBH Publishing Co., New Delhi.
4. Contemporary Plant Systematics, DW Woodland (1991) Prentice Hall, New Jersey
5. Plant Taxonomy, OP Sharma (2009) Tata McGraw Hill, Mumbai
6. Taxonomy of Angiosperms, BP Pandey (2007) S Chand & Co., New Delhi
7. Plant Systematics - Theory and Practices, Gurucharan Singh, Oxford and I.B.H. Publishing Co. New Delhi
8. Embryology of Angiosperms, SS Bhojwani & SP Bhatnagar, Vikash Publishing House, New Delhi
9. Plant Systematics: A Phylogenetic Approach WS Judd, S Christopher, Campbell, AE Kellogg, PF Stevens (1999), Sinauer Associates Inc. Publishers.
10. Plant Systematics, MG Simpson (2006), Elsevier Academic Press.
11. Variations and Evolution in Plants: G L Stebbins

MBT 202: MICROBIOLOGY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit- I **12h**

A brief idea of microbial diversity: present status and future challenges; principle of bacterial taxonomy, Bergey's manual, rRNA sequencing, molecular phylogeny, a general account of Archaea and Bacteria, Difference between Prokaryotes and Eukaryotes.

Unit- II **12h**

Nutritional types of microorganisms, symbiotic and non-symbiotic nitrogen fixation, *Rhizobium*-legume symbiosis and mycorrhiza.

Unit-III **12h**

Anoxygenic photosynthesis with special reference to light reaction in purple bacteria, methanogenesis. Genetics of bacteria: Genetic recombination- an overview; mechanisms of transformation, conjugation and transduction in bacteria, role of microorganisms in agriculture and medicines.

Unit-IV **12h**

Lytic cycle in T even phages and its regulation; lysogeny and its regulation in lambda phage; a brief account of viroids and prions.

Unit-V **12h**

Culture media, sterilization and disinfection, isolation, cultivation and maintenance of microorganisms, batch culture, synchronous culture and continuous culture methods, bacterial growth curve and factors affecting growth rates. Fermentation process and downstream processing; Basic design of a fermentor.

Suggested Readings:

1. General Microbiology, HG Schlegel (2001),Cambridge University Press, UK
2. Microbiology: An Introduction, GJ Tortora, BR Funke, CL Chess (2003),Benjamin Cummins.
3. Foundations in Microbiology, KP Talaro, B Chess (2011),8th edition, McGraw-Hill.
4. General Microbiology, RYStanier, JL Ingraham, ML Wheelis, PR Painter (1994), The McMillan Press Ltd. London
5. An Introduction to Microbiology, P Tauro, KK Kapoor, KS Yadav (1997), New Age International Pvt Ltd, New Delhi
6. A Text Book of Microbiology, RC Dubey, DK Maheswari (1999), S Chand & Sons, New Delhi
7. Microbiology: A Text Book of Microorganisms, General &Applied, CH Marshall (2012), General Books Ltd.
8. A Textbook of Basic & Applied Microbiology, KR Aneja, P Jain, R Aneja(2009), New Age International Pvt Ltd, New Delhi
9. A Textbook of Industrial Microbiology, JCruger (2004), Panima Publishing Corporation, New Delhi
10. Brock Biology of Microorganisms, MT Madigan, JM Martinko, PV Dunlap, DP Clark (2011), 13th edition, Pearson Education Inc.
11. Prescott's Microbiology, JM Willey, L Sherwood, CJ Woolverton (2018), 11th edition, McGraw-Hill.

MBT 203: CYTOGENETICS & PLANT BREEDING

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit - I **12h**

Cell cycle: control mechanism, role of cyclins and cyclin-dependent kinesis
Mitosis: stages, mitotic apparatus, cytokinesis
Meiosis: stages, synaptonemal complex
General account of cell-cell interaction

Unit – II **12h**

Chromatin organization and replication: Nucleosome and higher order organization, conformational changes and genetic activity, assembly/disassembly of histones during replication.
Karyotype analysis, chromosome-banding patterns: Linear differentiation of chromosome segments, types of chromosome banding, uses of chromosome banding in cytogenetics.

Unit – III **12h**

Modifications of Mendelian inheritance, linkage and crossing over, cytoplasmic inheritance, mechanisms of sex determinations in plants, linkage groups, sex-linked inheritance, X-chromosome inactivation

Unit – IV **12h**

Structural and numerical changes in chromosome, polyploidy and evolution, spontaneous and induced mutations, physical and chemical mutagens, molecular basis of spontaneous and induced mutations, transposable elements

Unit - V **12h**

Objectives of plant breeding, selection of self and cross-pollinated plants, hybridization, self and cross-pollinated plants, anthesis, self-sterility, male sterile lines, single, double and multiple crosses, mutation breeding

Suggested Readings:

1. The Cell: A Molecular Approach, GM Cooper (2000), Oxford University Press
2. Cell and Molecular Biology, G Karp (2002), John Wiley & Sons
3. Molecular Cell Biology, H Lodis (2000), WH Freeman Ltd.
4. The Cell Biology, SR Bolsover*et al* (2004), John Wiley & Sons. UK
5. The Cell, K Rogers (2011), Britannica Educational Publishing, UK
6. Cell & Molecular Biology, EDP DeRobertis, EMF DeRobertis (2001), Lippineott Williams & Wilkins, Bombay.
7. Principles of Genetics, DP Snustad, MJ Simmons (2000), John Wiley & Sons Inc. USA.
8. Cytogenetics, PK Gupta, Rastogi Publication.
9. Principles and Procedures of Plant Breeding: Biotechnological& Conventional Approaches, GS Chahal, SS Gosal, Narosa Publishing House, New Delhi.
10. Plant Breeding: Analysis and Exploitation of Variation, D Roy (2000), NarosaPublishing House, New Delhi.
11. Essentials of Plant Breeding, P Singh (2001), Kalyani Publishers, Hyderabad
12. Plant Breeding, BD Singh (1994), Kalyani Publications, New Delhi.

MBT 204: PLANT ECOLOGY&PHYTOGEOGRAPHY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit- I **12h**
Autecology and Population concepts: Characteristics, dynamics, density dependent and independent factors; population control.

Unit-II **12h**
Vegetation organization and characteristics: Ecological sampling and types; Ecological indexes and their interpretation, ecological niche and types, species diversity and types.

Unit-III **12h**
Ecosystem organization: Structure and functions, primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, ecological efficiencies), decomposition (mechanism, controlling factors), comparative account of nutrient cycles.

Unit - IV **12h**
Ecosystem stability: Concept (resistance and resilience), ecological perturbations (natural and anthropogenic) and their impact on ecosystems. Ecological succession: Models and mechanisms of ecological succession.

Unit- V **12h**
Phytogeography: definition and scope, Continental drift, endemism, factors governing distribution of plants, phytogeographical regions of India, plants endemic to Indian subcontinent.

Suggested Readings:

1. Fundamentals of Ecology, EPOdum (1996), Natraj Publishers, Dehradun
2. A Text Book of Plant Ecology, RSAmbasht (1990),Students Friends Publishers, Varanasi
3. A Textbook on Ecology & Environmental Science, PP Mahendran, P Rajan (2008), Agrotech Publishing Academy
4. Ecology, MBegon, JL Harper, CR Townsend (1996), Blackwell Science, Cambridge, USA.
5. Ecology and Environment, PD Sharma (2001), Rastogi Publications, Meerut.

MBP 201: Laboratory work based on course MBT 201 & 202**.**

Credit: 02
Maximum Marks: 50

Taxonomy:

1. Study of at least two members from each family with suitable sketches and description in technical terms
2. Description of specimens from locally available representative families
3. Collection and study of specimens for intra-specific variation
4. Field trips to nearby areas, compilation of field notes and preparation of herbarium sheets from collected plants (wild as well as cultivated)
5. Use of floras and herbarium for the identification (up to genus level) of specimens

Microbiology:

1. Sterilization, preparation of media, inoculation and staining (Gram staining)
2. Isolation of bacteria from soil, air and water; Streaking onto an agar plate and isolation of colonies
3. Isolation and enumeration of actinomycetes and fungi from rhizosphericsoils and seeds.
4. Isolation of *Rhizobium* bacterioids from legume root nodules
5. Antibacterial assay – disc-diffusion/agar-well method.
6. Oxidase test, Catalase test, Litmus milk test, Hydrogen Sulphide test
7. Carbohydrate fermentation test, Multiple-Tube Fermentation test.
8. Isolation of streptomycin-resistant bacteria
9. Screening and isolation of microbes for the production of enzymes

MBP 202: Laboratory work based on course MBT 203 &204

Credit: 02
Maximum Marks: 50

Ecology:

1. Determination of minimum quadrate size by species area curve method
2. Determination of minimum quadrate number by species area curve method
3. Determination of frequency of various species by quadrate method and preparation of frequency diagram
4. Determination of plant density by quadrate method
5. Determination of species abundance by quadrate method
6. Determination of relative frequency by quadrate method
7. Determination of relative density by quadrate method
8. Determination of basal area by quadrate method
9. Determination of relative dominance by quadrate method
10. Determination of IVI by quadrate method
11. Determination of community coefficient of two sties by quadrate method
12. Quantitative and qualitative community analysis: Carry out a project to determine the vegetative structure using characteristics such as frequency, abundance, density of different species and similarity index of different communities in a natural system
13. Field visit to natural ecosystems, identification of trophic levels, food webs and food chains

Cell Biology:

1. Preparation of fixatives and nuclear strains
2. Study of mitosis in plant material
3. Study of meiosis in pollen mother cell
4. Study of meiosis of translocation heterozygote, observation of special types of chromosomes, salivary gland chromosomes
5. Study of characteristics and behavior of B chromosomes using maize or any other appropriate material
6. Study of chromosomal aberration from micro-preparations and photo-micrographs
7. Observation of ultrastructural details of organelles (Photographs)

Genetics & Plant Breeding:

1. Induction of polyploidy using colchicines
2. Solving genetic problems laws of inheritance, gene interaction, recombination and gene mapping.
3. Use of hybridization techniques in self and cross-pollinated plants.

MBT 301: PLANT PHYSIOLOGY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit-I **12h**

Water and Mineral transport: water potential, mechanism of water transport through xylem, uptake and transport of ion and solutes across membranes (passive and active transport).
Phloem transport: mechanisms of loading and unloading of photo-assimilates

Unit- II **12h**

Photosynthesis: Basic principles of light absorption, light harvesting complexes, excitation energy transfer, photo-oxidation of water, mechanism of electron and proton transport, carbon assimilation- C_3, C_4 and CAM pathways of CO_2 fixation, photorespiration.

Unit- III **12h**

Respiration: Glycolysis, TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, alternative oxidase system

Unit-IV **12h**

Plant growth regulators: Biosynthesis, storage and mechanism of action of plant growth hormones (Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene and Brassinosteroids), hormone receptors, signal transduction and gene expression

The flowering process: Photoperiodism and its significance, endogenous clock and its regulation, initiation of flower primordial and its development, flowering stimulus, vernalization

Unit- V **12h**

Sensory Photobiology: structure and function of phytochrome, phytochrome induced plant responses, molecular mechanism of phytochrome action, cryptochrome and its role in photomorphogenesis. Seed germination and seed dormancy, climacteric fruit ripening. Leaf senescence, physiological effect of salt and water stress, heat stress and heat shock proteins.

Suggested Readings:

1. Seed Physiology and Biochemistry, JD Bernle, M Black (1992), Springer-Verlag.
2. Introduction to Plant Physiology, WG Hopkins, NPA Hunter (2009), fourth edition, John Wiley & Sons, USA.
3. Photosynthesis, DW Lender (2001),MercelDeker.
4. Plant Physiology, L Taiz, E Zeiger (2010), fifth edition, Sinurer Associates.
5. Plant Physiology, S Mukherji, AK Ghosh (1996), Tata McGraw Hill.
6. Introductory Plant Physiology, GR Noggle, CJ Fritz (1989), Prentice Hall
7. Biochemistry and Physiology of Plant Hormones, TC Moore (1989), Springer Verlag, New York, USA,

MBT 302: PLANT BIOCHEMISTRY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit- I **12h**

Law of mass action, dissociation of water and its ion product (K_w), pH, ionization of weak acids and weak bases, the Henderson-Hasselbalch equation, physiological buffers.
Biochemical energetics: General concept, laws of thermodynamics, entropy, enthalpy, free energy, redox-potential, energy rich phosphorus compounds, ATP as universal currency of energy.

Unit- II **12h**

Biosynthesis and degradation of carbohydrates in higher plants.
Biosynthesis of fatty acids, β-oxidation of fatty acids, glyoxylate cycle.
Structures of protein, Ramchandran plot.

Unit- III **12h**

Enzymology: General aspects, prosthetic groups and coenzymes, mechanism of catalysis, kinetics, Michaelis-Menton equation, bi-substrate reactions, active sites, factors contributing to the catalytic efficiency, enzyme inhibition, regulatory enzymes, isoenzymes, ribozymes.

Unit- IV **12h**

Biological nitrogen fixation: Nitrogenase enzyme, substrates for nitrogenase, reaction mechanism, regulation of nitrogenase. Inorganic nitrogen metabolism: Introduction, nitrate transport, nitrate and nitrite reductases, inhibitors, localization and regulation of nitrate and nitrite reductases, pathways of ammonia assimilation, regulation of nitrogen assimilation.

Unit- V **12h**

Sulphur and phosphorus metabolism: Sulphate uptake, activation and transfer, assimilatory pathways of sulphate reduction, transport and assimilation of phosphate.

Suggested Readings:

1. Plant Biochemistry, PM Gressholf (2000), John Wiley.
2. Plant Biochemistry, PM Dey, JB Harborne (2000),AcademicPress.
3. Concept in Biochemistry, R Boyer R (1999), Brooks/Cole Publ.
4. Biochemistry and Molecular Biology of Plants, BBuchanan, W Gruissem, RL Jones (2004), Amer. Soc. Plant Physiol.
5. Outlines of Biochemistry, EE Conn, PK Stumpf (1994), Wiley Eastern.
6. Plant Metabolism, DT Dennis (1998), Longman.
7. Plant Biochemistry and Molecular Biology, H Heldt (1997), Oxford Univ. Press.
8. Plant Biochemistry and Molecular Biology, PJ Lea, RC Leagood (1999), Wiley.
9. Lehningers Principles of Biochemistry, DL Nelson, MM Cox (2008), fifth edition, W. H. Freeman & Co, New York, USA
10. Biochemistry, LStryer (1993), W.H. Freeman.
11. Biochemistry, G Zubay (1993), W.C. Brown.
12. Biochemistry, JM Berg, JL Tymoczko, L Stryer (2011), Seventh Edition, Freeman & Co. New York, USA.

MBT 303: CELL &MOLECULAR BIOLOGY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit-I **10h**
DNA double helix, supercoiling, denaturation, fine structure of gene, coding and non-coding sequences, repetitive sequences, satellite DNA, overlapping gene.

Unit-II **12h**
DNA replication: creation of replication fork in prokaryotes and eukaryotes, elongation and termination of replication in prokaryotes and eukaryotes, rolling circle and D-loop models of DNA replication, DNA polymerases, ligases, topoisomerases.

Unit-III **16h**
Protein Synthesis: Transcription and translation in prokaryotes and eukaryotes, reverse transcription.
RNA Processing: Post-transcriptional modification of rRNA, tRNA and mRNA among eukaryotes.
Genetic code and its characteristics, post-translational modifications.
Protein Targeting and Sorting: Concept of signal peptide, Signal recognition particle (SRP), SRP receptor, transport of soluble and membrane bound proteins in Endoplasmic Reticulum.

Unit-IV **10h**
DNA recombination (Holliday model), DNA damage and repair (Photo repair and excision repair), Molecular mechanism of apoptosis.

Unit-V **12h**
Cellular Receptors and Signaling: Cell surface receptors, Signaling via G-Protein Linked receptors, cAMP, IP_3, Diacylglycerol as second messengers, adenylate cyclase system, inositol phosphate pathway, role of Ca^{2+} ions in signaling process, signal transduction via enzyme-linked surface receptors, receptor tyrosine kinases, steroid receptors.

Suggested Readings:

1. Molecular Biology of the Cell, B Alberts *et al.* (2002), Gerland.
2. Biochemistry and Molecular Biology of Plants, BB Buchanan*et al.* (2004). Amer. Soc. Plant Physiol.
3. Genes VIII, B Lewin (2002), Oxford.
4. DNA Structure and Function, PRR Sinden (1994), Academic Press.
5. Molecular Biology and Biotechnology, JM Walker, RRapley (2002),Panima.
6. Molecular Biology of the Gene ,JD Watson*et al.* (2004),Pearson Education.
7. Molecular Cell Biology, H Lodish*et al.* (2000), WH Freeman and Co., New York, USA.
8. Instant Notes on Molecular Biology, PC Turner, AG McLennan, AD Bates, MRH White (2001).

MBT 304: PLANT BIOTECHNOLOGY& BIOINFORMATICS

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit-I **12h**

Plant cell and tissue culture: Concept of cellular differentiation and totipotency
Somatic Embryogenesis and Organogenesis: Induction and controlling factors.
Haploids: Androgenic and gynogenic, role of haploids and polyploids in plant improvement

Unit - II **12h**

Gene cloning: Enzymes used in gene cloning, cloning and expression vectors, method of transformation, selection, identification, recombinant DNA libraries.

Unit - III **12h**

Plant genetic engineering: *Agrobacterium*-mediated gene transfer, Ti plasmid, co-integrate and binary vectors, plant viruses as vector, direct DNA transfer techniques, selection of transgenics, advantages and disadvantages of transgenic plants, molecular farming.

Unit - IV **14h**

Bioinformatics: Biological sequence and annotation; Tools and Databases - NCBI, EMBL, DDBJ, Patent databases, TAIR, PDB.
Online tools - BLAST, ORF finder, Primer3, protein motif and structure prediction tools.

Unit V **10h**

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR), Techniques in Drug Design, Microbial genome applications, Crop improvement.

Suggested Readings:

1. Plant Tissue Culture: Theory and Practice, SS Bhojwani, MK Razdan (1996), a revised edition, Elsevier Science Publishers, New York, USA.
2. Plant Tissue Culture: Applications and Limitations, SS Bojwani (1990), Elsevier Science Publisher, New York, USA.
3. Plant Cell Culture, HA Collins, S Edwards (1998), Bios Scientific Publishers, Oxford, UK.
4. Plant Tissue Culture: Techniques and Experiments, RD Hall (1999), Academic Press, New York.
5. Cryopreservation of Plant Cells and Organs, KK Kartha (1985), CRC Press, Boca Raton, Florida.
6. Plant Cell and Tissue Culture, IK Vasil, TA Thorpe (1994), Kluwer Academic Press, The Netherlands.
7. Biotechnology: Fundamentals and Applications, SS Purohit (2000), Agrobios, New Delhi.
8. Plant propagation by tissue culture, Volume 1, EF George, MA Hall, G-J De Klerk, (2008), The background (3rd ed.), Dordrecht: Springer.
9. Plant Tissue and Cell Culture, HE Street (1973), Blackwell Scientific Publ., London
10. Cell Culture and Somatic Cell Genetics of Plants, Vol. 5, F Constabel, Academic Press, Inc.
11. Plants from Test Tubes: An Introduction to Micropropagation, L Kyte, J Kleyn (1996)
12. Introduction to Bioinformatics, TK Attwood, DJ Parry-Smith (2004), Pearson Education (Singapore) Pvt. Ltd.
13. Plant Bioinformatics: Methods and Protocols, David Edwards (2007), Humana Press, New Jersey, USA.

MBP 301: Laboratory work based on course MBT 301 & 302.

Credit: 02
Maximum Marks: 50

Plant Physiology:

1. Determination of water potential.
2. Determination of osmotic potential by tissue weight method.
3. Demonstration of osmosis by using egg membrane.
4. Determination of osmotic potential of cell sap by plasmolytic method.
5. Effect of osmotic potential of external solution on the rate of imbibition.
6. Determination of stomatal index, frequency and pore area.
7. Effects of chemicals and temperature on the permeability of protoplasmic membrane.
8. Effect of various environmental factors on rate of photosynthesis.
9. Determination of gibberellic acid by half seed (cereal) method.
10. Effects of hormones on senescence.
11. Seed viability test.
12. Separation of anthocyanin pigment by paper and thin layer chromatography
13. Assay of auxin activity by *Avena* hypocotyl elongation
14. Assay of amylase induction by GA in plant tissues
15. Assay of effect of cytokinin on chlorophyll degradation by leaf disc method.

Biochemistry:

1. Preparation of buffers of various strength and pH.
2. Preparation of molal, molar, normal and percentage solutions and their dilutions.
3. Determination of reducing sugars of fruits by Nelson Somogyi's method
4. Estimation of starch from plant tissues by iodine reaction
5. Estimation of sugars from plant tissues by dinitrosalycilic acid
6. Qualitative tests for carbohydrates (Iodine, Anthrone, Fehlings, Benedict etc.)
7. Estimation of amino acids from plant tissues by ninhydrin reaction
8. Assay of phosphatase activity in plant cells
9. Assay of nitrate reducatase activity in cells
10. Preparation of standard curve of proteins (BSA) and estimation of protein content in extracts of plant material by Bradford's method.
11. Determination of specifications value of fats and oils
12. Determination of Vmax and Km
13. Determination of catalase activity
14. Demonstration of polyphenol oxidase.
15. Separation of photosynthetic pigments, lipids and amino acids by TLC/paper chromatography and calculating the Rf value
16. Demonstration of amylase activity and GA effect in germinating cereal seeds.
17. Effect of substrate concentration on activity of any enzyme and determination of its Km value.

MBP 302: Laboratory work based on course MBT 303 & 304.

Credit: 02
Maximum Marks: 50

Molecular Biology:

1. Assignments on related topics.
4. Separation of soluble proteins by (a) gel filtration (b) gel electrophoresis
2. Analysis of protein profiles through SDS-PAGE.
3. Isolation of plant DNA and its quantification by spectrophotometric method.
4. Isolation of DNA, and preparation of 'cot' curve.
5. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
6. Isolation of RNA and quantification by spectrophotometric method.
7. Separation of plant RNA by agarose gel electrophoresis and visualization by EtBr staining.

Plant Biotechnology:

1. Media preparation (e.g., MS medium, White's Basal Medium).
2. Surface sterilization
3. Micro-propagation technique
4. Inoculation of seeds of *Cajanuscajan*on agar medium.
5. Determination of dry and fresh weight of *in vitro* seedlings of *Cajanuscajan*
6. Organogenesis and somatic embryogenesis using appropriate explants.
7. Isolation of protoplasts from various plant tissues and testing their viability
8. Demonstration of protoplast fusion employing PEG.
9. Demonstration of androgenesis in *Datura*.

MBT 401: TRADITIONAL KNOWLEDGE, INTELLECTUAL PROPERTY RIGHTS & ENTERPRENURSHIP DEVELOPMENT

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit – I **12h**

Methods of ethnobiological study, Definition of Traditional Knowledge (TK), Traditional Knowledge Resource Classification (TKRC), importance of traditional knowledge, Traditional plant knowledge of Indian tribes - sources and problems with reference to central India, Traditional Knowledge Digital Library (TKDL)

Unit – II **12h**

Bioprospecting at species level, biopiracy, World Trade Organisation (WTO) and TK, provisions of Conventions on Biological Diversity (CBD) related to traditional knowledge
Entreprenureship development based on ethnic knowledge of wild plants (aromatic and medicinal)

Unit - III **12h**

Intellectual Property Rights (IPR): Definition & types of IPR, general account and importance of patents, copyrights (plants, utility and design) trademarks, geographical indicators and trade secret etc.

Unit - IV **12h**

Indian patent Act: conditions for patenting, provisional and complete specification, procedure for obtaining patents, international and national laws on patents, organization of patent offices in India, World Intellectual Property Organization (WIPO) and its role

Unit - V **12h**

Commercial cultivation of edible mushrooms (*Agaricus*, *Pleurotus* and *Volvariella)*, nursery and floriculture management, sericulture, bonsai techniques, marketing strategies of plants and their products.

Suggested Readings:

1. TKDL (www.tkdl.res.in) online resources
2. WIPO online resources (www.wipo.int)
3. Mushroom Cultivation in India, BC Suman V Sharma, B Suman& VP Sharma (2007), Daya Publisher, New Delhi.
4. Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact, PG Miles, S-T Chang (2004), CRC Press.

MBT 402: BIORESOURCE UTILIZATION

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit - I **12h**

Definition and classification of bioresources, their commercial utilization, Access and Benefit Sharing (ABS), concept of sustainable development, conservation strategies of plant resources (*in*- & *ex-situ* conservation).

Unit - II **12h**

Origin of agriculture, crop domestication, primary and secondary diversity centers of cultivated plants, introduction of crop plants, sources of variation, selection.

Unit - III **12h**

A general account including cultivation and uses of major cereals, oil seeds, legumes, forage and fodder crops, timber and non-timber (gums, resin, oil yielding) plants used by the tribes of central India, Bioenergy plants.

Unit-IV **12h**

Medicinal plants, bioactive molecules and therapeutic values of some ethno-medicinally important plants - Giloy, Brahmi, Safed Musli, Kalmegh, Satavari, Bel, Sarpgandha, Ashwagandha, Kali haldi Standardization of herbal drugs, Nutraceuticals and medicinal foods

Unit - V **12h**

Microbial Biofertilizers: Definition and types, importance of biofertlizers in agriculture.
Mass multiplication and use of blue-green algae, *Rhizobium, Azotobacter*, *Azospirillum* and *Azolla*.
Mycorrhizal fungi: benefits of mycorrhizal association, ecto and endomycorrhiza.
Fungi as biopesticides, industrially important fungal enzymes.

Suggested Readings:

1. Cyanobacteria: An Economic Perspective, NK Sharma, AK Rai, LJ Stal (2014), Wiley-Blackwell, UK.
2. Natural Products from plants, PB Kaufman, LJ Cseke, S Warber, JA Duke, HL Brielmann (1998), CRC Press, Boca Raton, USA, pp 343
3. Economic Botany: Principles & Practices, GE Wickens (2004), Springer.
4. Mycorrhizal Symbiosis, SE Smith & DJ Read (2010), Academic Press, pp 800
5. Mycorrhiza: Role & Applications, VS Mehrotra (2005), Allied Press, New Delhi, pp 359
6. Medicinal and Aromatic Plants in India, S Maiti & KA Geetha (2008), An e-book may be downloaded from http://nsdl.niscair.res.in/dspace/handle/123456789/742.
7. The Useful Plants in India, publication by CSIR, New Delhi
8. Hills Economic Botany, OP Sharma (1996), Tata McGraw Hill, New Delhi.
9. Essentials of Conservation Biology, RB Primack (1993).
10. Fungi: Biology and Applications, Kevin Kavanagh (2011), John Wiley & Sons, UK.
11. Cultivation of selected medicinal plants published by National Medicinal Plant Board 36, Janpath, New Delhi.
12. Herbal Drugs, SC Mandal, New Central Book Agency, New Delhi.
13. A Hand Book of Medicinal Plants, ND Prajati, SS Purohit, Agrobios (India) Jodhpur.
14. Biofertlizers Technology, S Kannaiyan, K Kumar, K Govindrajan (2007), Saujanya Books, New Delhi.

MBP 401: Field & lab works based on course MBT 401 & 402.

Credit: 02

Maximum Marks: 50

1. Visit to nearby tribal area to study the plant material used by local tribes as- cereals, oil-seeds, legumes, timber etc.
2. Collection of materials used by tribal for sustenance.
3. Morphological and histochemical features of cereals, oil seed, legumes and forest trees
4. Identification of important medicinal plants of the locality, common techniques used by tribes to extract active molecules from the plants and parts thereof.
5. Identification of poisonous and non-poisonous mushrooms
6. Study of mycorrhizal association.
7. *Azolla* as biofertiliser.

DMBT01: PLANT CONSERVATION AND BIOMETEOROLOGY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit – I **12h**
Population dynamics and conservation: Genetic variation and its loss, variation in natural populations, competition, metapopulations, mechanisms of population regulation, habitat specific demography, Life tables and types.

Unit – II **12h**
Species and habitat conservation: IUCN protected area categories, Red Data Book theory of reserve design, theory of island geography, Sustainability: types and models of sustainable development.

Unit – III **12h**
Climate change: Drivers and assessment of climate change; Greenhouse effects, Ozone layer depletion. Consequences of global warming: sea level rise, agriculture, natural vegetation, human implications, effects of increased CO2 on plants, Remote sensing and applications.

Unit – IV **12h**
Ecology of disturbed ecosystems: Ecosystem dynamics and stability, disturbances, impact of disturbances on the structure and functioning of terrestrial ecosystems, process of ecosystem recovery. Plant invasion in natural ecosystems: Control measures and restoration.

Unit – V **12h**
Leaf Energy fluxes: energy budget, fluxes and temperature, size, shape, Leaf economics spectrum. Leaf area index, biomass allocation, boundary layer conductance. Phenology: types and variation.

Suggested Readings:

1. Ecosystem Rehabilitation, Mohan K. Wali (1992), SPB Academic Publishing, The Hague, The Netherlands
2. Restoration of degraded land: concepts & strategies, JS Singh (1993), Rastogi Publications, Meerut
3. The Balance of Nature? Ecological Issues in the Conservation of Species and Communities,Stuart L. Pimm (1991), The University of Chicago Press, USA
4. Ecology and Field Biology, Robert L. Smith (2001), Benjamin Cummings
5. Essentials of Conservation Biology, Richard B. Primack (2010), Fifth Edition, Sinauer Associates Inc, USA.
6. Principles of Conservation Biology, Gary K. Meffe& C. Ronald Carroll (2006), Third Edition, Sinauer Associates Inc, USA,

DMBT02: APPLIED MICROBIOLOGY

Credit: 04
End-Term Examination Marks: 60
Continuous Internal Assessment Marks: 40

Unit - I **12h**

Microbes as tools for understanding the biological processes.
Microbes and environment: Pollution abatement, bioindicators, restoration of degraded ecosystems, biotransformation, biodegradation, bioremediation.

Unit - II **12h**

Application of microbes in fermentation processes: Types, design and maintenance of bioreactors, fermentative products; antibiotics, vitamins, enzymes
Medical microbiology: Microbes as causal agents of human and animal diseases; basic concepts of vaccines.
Fermentation, Downstream processing, product recovery and product development.

Unit – III **12h**

Role of microbes in relation to agriculture: microbial mineralization, Nitrogen & Phosphorous economy, biological control, PGPR, biodegradation of the agricultural residues.
Symbiotic associations: concepts, types and applications.
Microbes in food and dairy industry: fermented foods, microbial spoilage of food and dairy products, toxins

Unit-IV **12h**

Application of microbes in biofuel production, Extremophiles and their biotechnological applications, Microbes in nanotechnology

Unit – V **12h**

Microbes in recovery of metal (bioleaching) and oil; Cell and enzyme immobilization, microbial enzymes of industrial interest.

Suggested Readings:

1. Environmental Molecular Microbiology, Liu Wen-Tso and Janet K. Jansson (2010), Caister Academic Press
2. Mannual of Environmental Microbiology, CJ Hurst, RL Crawford, JL Garland, DA Lipson, AL Mills, LD Stetzenbach(2007), III Edition, Blackwell Publishing
3. A Text Book of Applied Microbiology, Vols. I to II, S Kannaiyan (2009), Associated Publishing Company

DMBT03: CLIMATE CHANGE & ENVIRONMENTAL MANAGEMENT

Credit: 04

End-Term Examination Marks: 60

Continuous Internal Assessment Marks: 40

Unit - I **12h**

Climate change: Drivers and assessment of climate change; Greenhouse effects, Ozone layer depletion, Use of fertilizer, pesticides and other chemicals in agriculture and hygiene and their disposal.

Consequences of global warming: sea level rise, agriculture, natural vegetation, human implications, effects of increased CO_2 on plants.

Unit - II **12 h**

Biodiversity: definition, level and types, biodiversity as natural resource, value of biodiversity, risks and its conservation, concepts of biodiversity management, biodiversity act of India and related International conventions.

Unit - III **12h**

Introduction and scope of environmental management, Environmental impact assessment (EIA), general guidelines for the preparation of environmental impact assessment.

Unit - IV **12h**

Scope and types of environmental audit, energy audit, cost benefit analysis, Environmental management plan, ISO 14000 standards and certification.

Unit - V **12h**

Basic principles of environmental risk management and environmental safety norms, Basic concepts of sustainable development, Status and strategies for bio-resource management, concepts and strategies of ecological engineering.

Suggested Readings:

1. Environmental Management: Principles & Practices, CJ Barrow (2005)
2. Environmental Management and Conservation, RK Khitaliya (2008)

DMBP01: *Field /lab works based on DMBT01/02/03*

(Credit: 02; Maximum Marks: 50)

1. Soil sampling and analysis for macro- and micronutrients
2. Plant water requirement assessment
3. Assessment of fertilizer inputs on crop growth
4. Assessment of planting density on crop growth
5. Impact of salinity on crop growth
6. Ecological foot print analysis
7. Study of soil texture and structure
8. Isolation of microbes from extreme habitats
9. Phosphatase activity test
10. Field study to observe diversity in leaf forms, flower, and methods of their pollination.
11. Students should be made aware to the common environmental problems, their consequences and possible solutions.

DMB05: Dissertation [**Credit: 04 (written report -03; presentation of the work -01)**; Maximum Marks: 100]

Excursion (Credits 02; maximum marks -50)

The Excursion tour to different parts of the country for phyto-geographical study and observation/collection of plant materials will be undertaken any time in between III& IV Semesters. However, the study report will be evaluated during III semester.