DR. HOMI BHABHA STATE UNIVERSITY, MUMBAI

Faculty of Science and Technology

M.Sc SYLLABUS FOR CORE AND SKILL ENHANCEMENT COURSES IN BOTANY

As Per U. G. C. Guidelines
Based on
Choice Based Credit System (CBCS)
BOTANY SEMESTER - WISE SYLLABUS
(Theory and Practicals)

To Be Implemented From Academic Year 2019 - 2020

Semester	Course Type	Course Code	Course Title	Credits
SEM I	Core Compulsory	MSBOCC101T	Plant Diversity I :Microbiology, Virology & Phycology	4
		MSBOCC101P		2
	Core Compulsory	MSBOCC102T	Plant Diversity II :Bryophytes, Pteridophytes, Paleobotany & Gymnosperms	4
		MSBOCC102P		2
	Core Compulsory	MSBOCC103T	Plant Physiology & Biochemistry	4
		MSBOCC103P		2
	Interdisiplinary Elective Course	MSBOIE101T	Genetics, Cell Biology & Plant Breeding	4
		MSBOIE101P		2
	Generic Elective Course	MSBOGE101T	Pharmacognosy	2
		MSBOGE102T	Biodiversity and Conservation	2
	Skill Enhancement Compulsory Course	MSBOSC101T	Presentation Skills	2
SEM II	Core Compulsory	MSBOCC201T	Plant Diversity III: Fungal Biology and Plant Pathology	4
		MSBOCC201P		2
	Core Compulsory	MSBOCC202T	Plant Diversity: Angiosperms (Taxonomy, Anatomy and Developmental Botany)	4
		MSBOCC202P		2
	Core Compulsory	MSBOCC203T	Ecosystem & Environmental Botany	4
		MSBOCC203P		2
	Interdisiplinary Elective Course	MSBOIE201T	Bioactive Molecules in Plants	4
		MSBOIE201P		2
	Skill Enhancement Compulsory	MSBOSC201T	Plant Tissue Culture-I	4
SEM III	Core Compulsory	MSBOCC301T	Instrumentation and Techniques-I	4
		MSBOCC301P		2
	Core Compulsory	MSBOCC302T	Cell and Molecular Biology-I	4
		MSBOCC302P		2
	Discipline Specific Elective	MSBODE301T	Plant Physiology, Biochemistry and Phytochemistry-I- Plant Biochemistry-I	4
		MSBOPR301P		2
	Discipline Specific Elective	MSBODE302T	Plant Physiology, Biochemistry and Phytochemistry-II- Phytochemistry	4
		MSBOPR302P		2
	Discipline Specific Elective	MSBODE303T	Molecular Biology, Cytogenetics and Biotechnology-I (Cancer and development)	4
		MSBOPR303P		2
	Discipline Specific Elective	MSBODE304T	Molecular Biology, Cytogenetics and Biotechnology-II (rDNA Technology)	4
		MSBOPR304P		2
	Discipline Specific Elective	MSBODE305T	Ecology, Environmental Botany and Biotechnology-I (Ecological Concepts and Climate Change)	4
		MSBOPR305P		2
	Discipline Specific Elective	MSBODE306T	Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution)	4
		MSBOPR306P		2
	Generic Elective Course	MSBOGE301T	Environmetal Impact Assesment	2
	Skill Enhancement Compulsory Course	MSBOSC302T	Science Communication	2

SEM IV	Core Compulsory	MSBOCC401T	Instrumentation and Techniques-II	4
		MSBOCC401P		2
	Core Compulsory	MSBOCC402T	Cell and Molecular Biology-II	4
		MSBOCC402P		2
	Discipline Specific Elective	MSBODE401T	Plant Physiology, Biochemistry and Phytochemistry-III- Plant Biochemistry-II	4
		MSBOPR401P		2
	Discipline Specific Elective	MSBODE402T	Plant Physiology, Biochemistry and Phytochemistry-IV- Plant Biochemistry-III	4
		MSBOPR402P		2
	Discipline Specific Elective	MSBODE403T	Molecular Biology, Cytogenetics and Biotechnology-III (Immunology and Techniques)	4
		MSBOPR403P		2
	Discipline Specific Elective	MSBODE404T	Molecular Biology, Cytogenetics and Biotechnology-IV (Applications of rDNA Technology and Nanotechnology)	4
		MSBOPR404P		2
	Discipline Specific Elective	MSBODE405T	Ecology, Environmental Botany and Biotechnology-III (Conservation, Policies and Practices)	4
		MSBOPR405P		2
	Discipline Specific Elective	MSBODE406T	Ecology, Environmental Botany and Biotechnology-IV (Technologies for Pollution Control)	4
		MSBOPR406P		2
	Skill Enhancement Compulsory	MSBOSC401T	Plant Tissue Culture II	4
		MSBOSC402T	Applied Botany	4

SEM III

Course Type: Core Compulsory

Course Code: MSBOCC301T

Course Title: Instrumentation and Techniques-I

Credits-4

Objectives:

- This paper teaches the basics of various types of techniques and instrumentation such as bioinformatics, spectrophotometry, chromatography, electrophoresis and centrifugation to carry out routine and advance research in Botany.
- It will introduce applications of computational biology in diverse areas of biological sciences and provide training in the use of statistics in biological sciences.
- The emphasis is on principle of the technique, instrumentation design, methodology of sample preparation and handling of equipment and application in the field of Botany.
- In addition to the above, paper also discusses mole concept, preparation of various pH solutions and buffers.

Outcome:

- Students will be trained in statistical concepts and principles relevant to biological data and their applications.
- Students will learn necessary skills in the use of databases and online tools related to biological data.
- Independently work on various instruments and understand their principle.
- Able to prepare various types of solutions and calculate mole fraction, molality, molarity, etc.

Course Code: MSBOCC301T

Course Title: INSTRUMENTATION AND TECHNIQUES - 1

Course Credit: 4 **Total contact hours: 60 Hrs** **Allotted hours**

PAPER -1 SEM- 3 Techniques and Instrumentation-I

UNIT – I **15**

- Biostatistics
  Hypothesis testing: Theory of errors – Type I and Type II errors, Null Hypothesis, z-test, Test of significance.
  Introduction to ANOVA, One-way & two way ANOVA, Dunett's test.
  Randomized Block Design and Latin Square. (5 problems to be solved in each category)
- Laboratory practices and safety in laboratory: General safety measure, Chemical hazards, Physical hazards, Biological hazards, spillage, and waste disposal, disposal of radioactive waste, first aid.

Unit II: Bioinformatics **15**

- Introduction to Bioinformatics, Nature of biological data, Overview of available Bioinformatics resources on the web, NCBI/EBI/EXPASY etc.
- Biological Databases: Nucleic acid sequence databases, GenBank/EMBL/DDBJ Protein sequence databases, SwissProt, UniProtKB, structural databases, PDB, Database search engines, Entrez
- Overview/concepts in sequence analysis, Pair wise sequence alignment algorithms, Database Similarity Searches –BLAST, FASTA Multiple sequence alignment, CLUSTALW.

15

Unit III: pH and Buffers; Electrophoresis

- pH and buffer solutions: Molarity and moles, acids and bases, hydrogen ion concentration, dissociation of acids and bases, measurement of pH, titration curves. Buffer solutions, Physiological Buffers.
- Electrophoretic techniques
- Theory and application of Polyacrylamide and Agarose gel electrophoresis; Low and high voltage electrophoresis; Capillary electrophoresis; 2D Electrophoresis
- Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

15

Unit IV: Microscopy & Spectroscopy

- Principles, instrumentation, working and applications of :
- Fluorescence microscope, TEM, SEM,
- Biological sample preparation for electron microscopy
- Principle, application and instrumentation of UV-VIS spectrophotometry; IR (infra-red) spectrophotometry; Spectrofluorometry; Luminometry;
- Atomic spectrophotometry; Mass spectrometry; ESR (electron spin resonance) and NMR (nuclear spin resonance).

Reference Books

- Bauman R.P. Absorption Spectroscopy. John Wiley, New York Dixon R.N. Spectroscopy and Structure. Mathuen, London Sacks R.D. Emission Spectroscopy. John Wiley, New York
- Pesez M and Bartos J. Colorimetric and Fluorometric Analysis of Organic Compounds and drugs, Dekker, New York. Becker R.S. Theory and interpretation of fluorescence and phosphorescence, Wiley interscience, New York.
- Guilbault G.G. Practical Fluorescence: Theory, methods and Techniques. Dekker, New York.
- Dean J. and Rains T. Flame emission and atomic absorption. Dekker, New York. Brech F. Analysis in instrumentation. Vol. 6. Plenum, New York.

- Bell R. J. Introductory Fourier Transform spectroscopy. Academic Press, New Yrk. Colthup N.B., Daly L.H. and Wiberley S.E. Introduction to Infra-red and Raman Spectroscopy 2nd Ed. Academic Press. New York.
- Kolthoff I.M. and Elving P.J. Treatise on analytical Chemistry, Wiley Interscience, New York.
- Williams D.A.R. and Mowthorpe D.J. Nuclear Maganatic Resonance Spectroscopy. John Wiley, New York.
- Watson I.J. Introduction to Mass spectroscopy, Raven, New York. Giddings J.C. Principles and Theory, Dynamics of Chromatogtraphy Part I Dekker, New York.
- Grob R.L. Modern Practices of Gas Chromatography. 2nd Ed. John Wiley, New York.
- Simpson C.F. Techniques in liquid chromatography, Wiley-Heyden, New York.
- Horvath C. HPLC Vol.I Academic Orlando.
- F.L. Fritz J.S., Gjerde D.T. and Pohlandt C. Ion chromatography,
- A. Huthig, Heidelberg Yau W. W., Kirkland J.J. and Bly D.D. Modern size exclusion chromatography, Wiley Interscience, New York. Bailey P.L. Analysis and ion selective electrodes 2nd Ed.
- Heyden, London. Bates R.G. Determination of pH: Theory and Practices, 2nd Ed. John Wiley, New York.
- Willard H.F., Merritt L.L., Dean, J.A. and Settle F.A. Instrumental Method of analysis. CBS Publishers and distribution, New Delhi
- Sharma, B.K. Principal of analytical chemistry, Merut Publication, Merut.
- Hames B.D. and Rickwood D. Gel electrophoresis of Proteins: A practical Approach 2nd Ed. IRL Press, Oxford.
- Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989
- Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983
- Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H. , John Wiley, New York, 2001
- Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
- Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003
- Bioinformatics and Molecular Evolution – Higgs PG and Attwood, TK
- An Introduction to Biometry- A. M. Mungikar
- Statistical methods for Agricultural workers- Panse V. G. and Sukhatme
- A Textbook of Agricultural Statistics by R. Rangaswamy
- Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983

Course Type: Core Compulsory

Course Code: MSBOCC301P

Course Title: Instrumentation and Techniques-I

Credits-2

PRACTICALS: Instrumentation and Techniques-I MSBOCC301P **Allotted hours 60**

1. Hypothesis testing, Normal deviate test
2. ANOVA- one way & two way.
3. Randomized block Design and Latin square
4. Multiple alignments/ Phylogenetic tree/BLAST/FASTA/Motif finding
5. Preparation of buffers (phosphate and acetate)
6. Preparation of molar and other solution and setting of pH.
7. pKa value of a buffer/ amino acids using pH meter.
8. Industrial visit and report submission.

Course Type: Core Compulsory

Course Code: MSBOCC302T

Course Title: Cell and Molecular Biology-I

Credits-4

Objectives:

- This paper teaches the basics of cell wall structure and functions of nucleic acids, biological membranes, DNA replication, repair and recombination

Course outcomes (Students will be learning.....)

- Current state of knowledge about the plant cell structure and their turn over, starting from cell wall to chromatin, in relation to their functions.
- What are the components of endo-membrane systems and mechanisms governing intracellular trafficking in plant cells?
- What is the role of plant cytoskeleton and accessory proteins in major cellular processes of plants?
- What are various components of the eukaryotic nuclear and organellar genome, with special reference to their regulatory role
- What are the principle mechanisms of genome replication, maintenance, function?

Course Code:	Course Title:	Allotted hours
MSBOCC302T	Cell & Molecular Biology-I	
Course Credit: 4	Total contact hours: 60 Hrs	

Unit I: Cell Wall Structure and Functions of Nucleic Acids **15Hrs**

- Cell Wall: Temporal and Spatial dynamism in structure, Structural and Functional roles, in planta and ex planta uses, Cell Wall Biotechnology
- Chemical structure of DNA and Base composition, biologically important nuleotides, Watson - Crick Model, Supercoiled DNA, Conformation of nucleic acids: A-, B-, Z-, DNA, t-RNA, micro-RNA. Stability of nucleic acid structure

Unit II: Biological Membranes, DNA Replication, Repair and Recombination **15Hrs**

- Biological membranes: from PLP model to Dynamically Structured Mosaic Model
- Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

Unit III: Cytoplasmic Components RNA Synthesis and Processing I **15 Hrs**

- Cytoplasmic components: Endomembrane systems, organellar architecture,
- Protein sorting and vesicular traffic.

- Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination.

Unit IV: Biopolymers RNA Synthesis and Processing II **15Hrs**

- Biopolymers: Structural and functional aspects of cytoskeleton and
- associated motor molecules, their role in cell organization and movement

- RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

Suggested readings

Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

DeRobertis, E.D.P. and DeRobertis, E.M.F. 2006 Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.

Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Lodish, **H.,** Berk, A. and 6 more. (2007) Molecular Cell Biology 6th edition. W. H. Freeman.

!-Genetics A Molecular Approach Third Edition by Peter J. Russell Benjamin Cummings San Francisco Boston New York

Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India

Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York.

Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.

Freifelder D and Malacinsk:i GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK

Krebs JE., Kilpatrick STand Goldstein ES. (2013). Lewin' GENES XI, Jones & Bartlett Learning. Burlington, MA.

Course Type: Core Compulsory

Course Code: MSBOCC302P

Course Title: Cell and Molecular Biology-I

Credits-2

PRACTICALS: Cell and Molecular Biology-I MSBOCC302P

1 Isolation of plasmids and Genomic DNA from E. coli cells. Quantification of DNA using spectrophotometric method

2 Agarose gel electrophoresis of plasmid and chromosomal DNA

3 Separation of proteins by one dimensional gel electrophoresis.

4 Restriction endonuclease digestion of plasmid and chromosomal DNA of E. coli cells

5 Transformation of competent E. coli cells, Colony hybridization

6 Southern blotting

7 Amplification of known DNA sequences by Polymerase Chain Reaction

Course Type: Discipline Specific Elective

Course Code: MSBODE301T

Course Title: Plant Physiology, Biochemistry and Phytochemistry-I- Plant Biochemistry-I

Credits-4

Objectives:

Course outcomes (Students will be able to.....)

- Understand the concept of Enzymes in a broader perspective
- Understand physiological & biochemical role of Vitamins in the field of Nutrition
- Have a better understanding of physiological & biochemical aspects of cell wall and
- membrane

Course Code:	Course Title:
MSBODE301T	**Plant Physiology, Biochemistry & Phytochemistry-I Plant Biochemistry-I**

Course Credit: **4** Total contact hours: 60 Hrs **Allotted hours**

Unit I: Bioenergetics and Enzymes **15 Hrs**

- **Bioenergetics**: The Laws of Thermodynamics, Concept of Entropy, Free Energy
- **Enzymes as Biological Catalysts**: The Properties of Enzymes, The Active Site, Mechanisms of Enzyme Catalysis, Enzyme Kinetics

Unit II: Vitamins and Coenzymes **15 Hrs**

- **Vitamins**: Structure, Properties, Source and Deficiency of water and fat soluble Vitamins
- Role of Vitamins as Coemzyme

Unit III: Nucleotide Metabolism **15 Hrs**

- **Purine and Pyrimidine**: Biosynthesis and Regulation.
- Recycling of Purine and Pyrimidine nucleotides by salvage pathways

Unit IV: Biochemistry of Membrane and Cell Wall **15 Hrs**

- **Structure and function of membranes**: Chemical composition, Functions of Membranes, Membrane carbohydrates, Membrane proteins and Membrane lipids
- **Biochemistry of plant cell wall**: Cellulose, Hemicelluloses, Lignin, Pectin, Suberin and Cutin.

Suggested Readings

Goodwin and Mercer **Plant Biochemistry**
Lehninger and Nelson D.L. **Principles of Biochemistry**
Gerald Karp (2010) **Cell & Molecular Biology: Concepts & Experiments**
Taiz and Zeiger **Plant Physiology**
Gerald F. Combs & James P. McClung (2017) **The Vitamins: Fundamental Aspects in Nutrition and Health**
Rajan Katoch (2011) **Analytical Techniques in Biochemistry & Molecular Biology**
Stryer L. **Biochemistry**
Lodish H. and Darneu J. **Molecular Cell Biology**
Dey PM and Harborne JB **Plant Biochemistry**
Buchanan (2015) **Biochemistry & Molecular Biology of Plants**

Course Type: Discipline Specific Elective

Course Code: MSBODE302T

Course Title: Plant Physiology, Biochemistry and Phytochemistry-II- Phytochemistry

Credits-4

Objectives:

Course outcomes (Students will be able to…..)

- Understand the biosynthetic pathways and their interrelationship.
- Undertake extraction and isolation of phytochemicals using different techniques
- Understand the use of secondary metabolites as neutraceuticals

Course Code:	Course Title:
MSBODE302T	**Plant Physiology, Biochemistry & Phytochemistry-II Phytochemistry**

Course Credit: **4** Total contact hours: 60 Hrs **Allotted hours**

Unit I: Secondary Metabolism **15 Hrs**

- General biosynthetic pathways in the formation of secondary metabolites
- Biosynthesis and role of following class of compounds
    - Phenols,
    - Phenylpropanes,
    - Coumarinns,

- Lignins,
- Flavonoids,
- Alkaloids,
- Tannins,
- Terpenes.

Unit II: Extraction Techniques for Phytochemicals **15 Hrs**

- Conventional Extraction Methods: Maceration, Percolation, Decoction, Reflux, Distillation and Soxhlet extraction
- Modern Extraction Methods: Pressurized liquid extraction (PLE), Supercritical Fluid Extraction (SFE), Ultrasound assisted extraction (UAE), Microwave Assisted Extraction (MAE), Pulse Electric Field (PEF), Enzyme assisted extraction (EAE)

Unit III: Separation Techniques for Phytochemicals **15 Hrs**

- Separation methods: Separation based on Adsorption properties
  - Partition coefficient
  - Molecular size
  - Ionic strength
- Modern techniques:
  - Preparative GC
  - SFC
  - Molecular imprinted technology
  - Simulated moving bed chromatography

Unit IV: Phytochemicals as Neutraceuticals **15 Hrs**

Occurrence, Chemical nature, medicinal and health benefits of following.

- Carotenoids – i) α & β - Carotene ii) Lycopene iii) Xanthophyll (Lutein)
- Limonoids – d-Limonene
- Saponins – i) Glycyrrhizin ii) Shatavarins
- Flavonoids – i) Resveratrol ii) Rutin iii) Hesperidin iv) Naringin v) Quercetin
- Anthocyanins
- Phenolic acids:- Ellagic acid

Suggested readings

Goodwin and Mercer Plant Biochemistry
Taiz and Zeiger Plant Physiology
Dey PM and Harborne JB Plant Biochemistry
Lehninger and Nelson D.L. Principles of Biochemistry
Gerald Karp (2010) Cell & Molecular Biology: Concepts & Experiments
Taiz and Zeiger Plant Physiology

Gerald F. Combs & James P. McClung (2017) The Vitamins: Fundamental Aspects in Nutrition and Health
Rajan Katoch (2011) Analytical Techniques in Biochemistry & Molecular Biology
Pharmacognosy Phytochemistry – Medicinal Plants – Jean Brunetton,
Medicinal Plant – Their Bioactivity, Screening and Evaluation – Published by CSIR
Textbook of Pharmacognosy – Trease and Evans – 14th edition

Course Type: Discipline Specific Elective

Course Code: MSBOPR301P and MSBOPR302P

Course Title: Projects

Credits-4

Research Project MSBOPR301P and MSBOPR302P

Objectives of the Course: As the part of discipline specific elective course plan, the III and IV semester is allotted for doing research on subject area related to Plant Physiology, Biochemistry & Phytochemistry or any other related area in consultation with the research supervisor allotted to the student. Before the start of the research project, the students have to undergone Practical training on the basic experiments related to Plant Physiology, Biochemistry & Phytochemistry under the guidance of the respective supervisor. This is to ensure confidence in handling the methodological part of the project work.

Practical training on the basic experiments related to Plant Physiology, Biochemistry & Phytochemistry (**MSBOPR301P Total credits -02)**

Objectives of the Course: The objective of the programme is for evaluating the expertise and on hands-on experience of the student in handling research problems in the field of Plant Physiology, Biochemistry & Phytochemistry. Prior to the lab work, the student has to do Practical training on the basic experiments related to Plant Physiology, Biochemistry & Phytochemistry.

Presentation of the Research proposal (**MSBOPR302P Total credits- 02)**

Objectives of the course. In the first phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the back ground of the work, detail review of literature, Objectives and methodology to be used and the expected outcomes of the research proposal

Course Code:	Course Title:
MSBOPR301P	**Plant Physiology, Biochemistry & Phytochemistry-I** Practical training on the basic experiments related to Plant Physiology, Biochemistry & Phytochemistry.

Course Credit: **2** Total contact hours: 30 Hrs

1. Enzyme kinetics: Effect of substrate variation on the activity of enzyme.
2. Preparation of Acetone powder
3. Preliminary Phytochemical screening of the above prepared extracts and their comparative study
4. Estimation of polyphenols.
5. Extraction and estimation of pectin
6. Estimation of cellulose
7. Protein Extraction and estimation

Course Code:	Course Title:
MSBOPR302P	**Plant Physiology, Biochemistry & Phytochemistry-I**

Course Credit: **2** Total contact hours: 60 Hrs

Project Work

In the first phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the back ground of the work, detailed review of literature, objectives and methodology to be used and the expected outcomes of the research proposal

Course Type: Discipline Specific Elective

Course Code: MSBODE303T

Course Title: Molecular Biology, Cytogenetics and Biotechnology-I (Cancer and development)

Credits-4

Course Objectives:
The objective of the present course content is to provide a foundation and background in cellular transport and cell communication, development at the molecular level in the plant and animals and cancer biology

Course Learning Outcomes:
The students will be learning
1. Current state of knowledge about the plant cell membrane transport of the molecules within and outside the cells. Communication of the cells
2. What are the components of signaling systems and mechanisms governing signaling pathways in biological systems?
3. How cells are tightly regulated and once the regulation is disturbed because of physical, chemical or biological means how the fate of the cell is?
4. How the body plan is determined at the early stage of development in plants and animals?

Course Code:	Course Title:	
MSBODE303T	**Molecular Biology, Cytogenetics & Biotechnology-I (Cancer and Development)**	
Course Credit: **4**	Total Contact Hours: 60 Hrs	**Allotted hours**

Unit I Membrane Transport and Cell Communication **15 Hrs**

Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior. Cellular communication: general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins.

Unit II Cell Signaling **15 Hrs**

Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, and regulation of signaling pathways, plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

Unit III Cancer Biology **15 Hrs**

Cancer cells: Characteristics, division, spread, treatment. Course of cancer cell formation, Carcinogens: radiations, chemicals, oncogenic virus. Cancer and mutations, reproductive properties of transformed animal cell in culture, oncogenes, protoncogenes and their conversion. Oncogenes and growth factors.

Unit IV Early Development **15 Hrs**

Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum.* Genetic regulation of development in Drosophila Developmental stages in Drosophila – embryonic development, imaginal discs, homeotic genes

Suggested readings

1. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Lodish, H., Berk, A. and 6 more. (2007) Molecular Cell Biology 6th edition. W. H. Freeman.

5. I-Genetics A Molecular Approach Third Edition by Peter J. Russell Benjamin Cummings San Francisco Boston New York

6. Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India

7. Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York.

8. Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.

9. Freifelder D and Malacinski GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK

10. Krebs JE., Kilpatrick ST and Goldstein ES. (2013). Lewin' GENES XI, Jones & Bartlett Learning. Burlington, MA.

Course Type: Discipline Specific Elective

Course Code: MSBODE304T

Course Title: Molecular Biology, Cytogenetics and Biotechnology-II (rDNA Technology)

Credits-4

Course Objectives:
The objective of the present course content is to provide a foundation and background in recombinant DNA technology, cloning and expression vectors and their applications, DNA sequencing and amplification techniques, DNA libraries, genomic arrays and protein-DNA interactions

Course Learning Outcomes:
The students will be learning
1. Current state of knowledge about the basic tools used in the recombinant DNA technology.
2. What are different types of cloning and expression vectors, inclusion bodies and plant based vectors?
3. Different types of PCR, How primers are design? Applications of PCR. How DNA sequencing is achieved. Different types of DNA sequencing techniques.
4. How DNA libraries are constructed? What is the role of DNA libraries in molecular biology?
5. How genomic arrays are constructed? DNA foot printing and study of protein-protein interactions.

Course Code:	Course Title:	
MSBODE304T	**Molecular Biology, Cytogenetics & Biotechnology-II (rDNA technology)**	
Course Credit: **4**	Total contact hours: 60 Hrs	**Allotted hours**

Unit I Recombinant DNA Technology **15 Hrs**

Restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labeling of DNA: nick translation, random priming, radioactive and non-radioactive probes.

Unit II Cloning and Expression Vectors **15 Hrs**

M13mp vectors; Bluescript vectors, Lambda vectors; Principles for maximizing gene expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system.

Unit III DNA Amplification and Sequencing **15 Hrs**

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing.

UNIT IV DNA LIBRARIES, GENOMIC ARRAYS AND PROTEIN-DNA INTERACTIONS **15 Hrs**

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation.

Course Objectives:

The objective of the present course content is to provide a foundation and background in recombinant DNA technology, cloning and expression vectors and their applications, DNA sequencing and amplification techniques, DNA libraries, genomic arrays and protein-DNA interactions

Course Learning Outcomes:

The students will be learning

1. Current state of knowledge about the basic tools used in the recombinant DNA technology.

2. What are different types of cloning and expression vectors, inclusion bodies and plant based vectors?

3. Different types of PCR, How primers are design? Applications of PCR. How DNA sequencing is achieved. Different types of DNA sequencing techniques.

4. How DNA libraries are constructed? What is the role of DNA libraries in molecular biology?

5. How genomic arrays are constructed? DNA foot printing and study of protein-protein interactions.

Suggested readings

1. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Lodish, H., Berk, A. and 6 more. (2007) Molecular Cell Biology 6th edition. W. H. Freeman.
5. I-Genetics A Molecular Approach Third Edition by Peter J. Russell Benjamin Cummings San Francisco Boston New York
6. Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
7. Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York.
8. Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.
9. Freifelder D and Malacinski GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK
10. Krebs JE., Kilpatrick ST and Goldstein ES. (2013). Lewin' GENES XI, Jones & Bartlett Learning. Burlington, MA.

Course Type: Discipline Specific Elective

Course Code: MSBOPR303P and MSBOPR304P

Course Title: Research Project

Credits-4

Research Project MSBOPR303P and MSBOPR304P

Objectives of the Course: As the part of discipline specific elective course plan, the III and IV semester is allotted for doing research on subject area related to Cytology, Molecular biology and Plant Biotechnology or any other related area in consultation with the research supervisor allotted to the student. Before the start of the research project, the students have to undergone Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology under the guidance of the respective supervisor. This is to ensure confidence in handling the methodological part of the project work.

Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology **MSBOPR303P Total credits -02**
Objectives of the Course: The objective of the programme is for evaluating the expertise and on hands-on experience of the student in handling research problems independently in the areas of molecular biology and genetic engineering. Prior to the lab work, the student has to do Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology.

Presentation of the Research proposal **MSBOPR304P Total credits- 02**
Objectives of the course: In the first phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the back ground of the work, detail review of literature, Objectives and methodology to be used and the expected outcomes of the research proposal

Course Code:	Course Title:
MSBOPR303P	**Molecular Biology, Cytogenetics & Biotechnology-I** Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology
Course Credit: **2**	Total contact hours: 60 Hrs

1 Mitosis and Meiosis in plant
2 Preparation of Solutions: Molar, Normal and Percentage solutions and calculations
3 Calibration of pH meter and determination of pH of solutions
4 Preparation of Buffers: Phosphate buffer, Tris- HCl buffer, Citrate buffer, Acetate buffer
5 Plant tissue culture: preparation of Stock solution and culture media, Callus culture – leaf or internode
6 Cell suspension culture and Encapsulation of zygotic
7 Determination of soluble constituents in callus system by TLC
8 Purification of enzyme proteins by salt precipitation

Course Code:	Course Title:
MSBPR304P	**Molecular Biology, Cytogenetics & Biotechnology-II**
Course Credit: **2**	Total contact hours: 60 Hrs

Project Work

In the first phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the back ground of the work, detail review of literature, Objectives and methodology to be used and the expected outcomes of the research proposal

Course Type: Discipline Specific Elective

Course Code: MSBODE305T

Course Title: Ecology, Environmental Botany and Biotechnology-I (Ecological Concepts and Climate Change)

Credits-4

COURSE OBJECTIVES:

The objective of the course is to provide knowledge and understanding of different aspects of atmosphere, hydrosphere and lithosphere; Principles and concepts of ecosystem; Global biogeochemical cycles .The students will become aware of the interrelationships between biosphere and environmental components understand basic knowledge of ecological principles, **Nature and natural resources,** Climate change and Climate projections for the 21st century.

On completion of the course, the students will be:

- Aware of the basics of environment
- Acquainted with different principles and concept of ecology
- Know about **nature and natural resources, forest resources, important research institutes**
- Able to appreciate the process the effects of **Climate change,** Climate projections and information about Ozone Cell

Course Code:	Course Title:	
MSBODE305T	**Ecological Concepts and Climate Change**	
Course Credit: **4**	Total contact hours: 60 Hrs	**Allotted hours**

UNIT-I Ecological Concepts **15**

- Our Environment: Geological Consideration; Atmosphere; Hydrosphere; Lithosphere; Biosphere and Functions; Scope of Ecological studies
- Principles and concepts of ecosystem
- Global biogeochemical cycles - carbon cycle, nitrogen cycle, phosphorus cycle, sulphur cycle; Interventions in cyclic processes and effects.
- Ecological succession - types and causes; Concepts of pioneers; Seres, Climax.
- Principles of Limiting Factor, Liebigs Law of the minimum, Shelford Law of Tolerance

UNIT-II Nature and natural resources **15**

- Nature and natural resources their conservation and associated problems, Use of resources and sustainable development
- Water resources: Distribution of water on Earth; Use, over exploitation of surface and ground water; Dams: Benefits and problems; Flood and Drought

- Mineral resources in India; Use and exploitation, Impact of Mining Activity on land and water resources.
- Land as a resource; Land degradation, landslides, soil erosion, desertification

UNIT-III Forest resources **15**

- Forest resources: Uses, ecological importance of forests, forest management strategies, Deforestation and its effects, Protection of forests from natural and man-made fires.
- Effects of air pollution on forests and forest die back.
- Role of afforestation and forest regeneration in absorption of CO_2.
- Wild life resources and conservation measures, Institutions looking after forest management: Indian Council of Forestry Research and Education (ICFRE) & Wildlife Institute of India- Dehradun; IIFM- Bhopal)

UNIT-IV Climate Change **15**

- Carbon sequestration and disturbance in C cycle, Climate change, causes and effects, Future scenario; Impact of climate change on agriculture, forestry, water resources, coastal ecosystem and dynamics.
- Climate change and food security; Contribution of agriculture and forestry to climate change.
- Climate projections for the 21st century, Changes in global mean surface temperature, spatial distribution of surface temperature and precipitation changes
- Changes in the ocean and sea ice
- Mandate for Ozone Cell, Ministry of Environment & Forests, Government of India

Reference Books:

1. Ambhast, R. S. (1998). *A Text Book of Plant Ecology*, 9th edition,
2. Begon, M., Townsend, C. R. and Harper, J. L. (2005). *Ecology: From individuals to Ecosystems* 4th edition, Wiley-Blackwell.
3. Carla W. Montgomory (2013). Environmental Geology by Mc Graw Hill Education, (10th Edition)
4. Coates, D. R. (1980). Environmental Geology-John Wiley & Sons, NY.
5. Grigg, Neil S. (2009). Water resources management: Principles, regulations, and cases, McGraw Hill Professional.
6. Gurdev, Singh (2007). Land resource management, Oxford publishers.
7. Jaidev, Somesh (2010). Natural resources in 21st century. Oxford Publishers.
8. Kathy Wilson Peacock (2010) Natural resources and sustainable developments. Viva books.
9. Kudrow, Nikolas (2009).Conservation of natural resources, Nora Science, New York.
10. Kumar, H.D. (2001). Forest resources: Conservation and management. Affiliated East West Press.
11. Lynch, Daniel R. (2009). Sustainable natural resource management for scientists and engineers. Cambridge University Press.
12. Mishra, S.P. (2010). Essential Environmental Studies, Ane Books.

13. Mukherjee, B. (1996) *Environmental Biology*, 1st edition, Tata Mcgraw Hill.
14. Odum, E.P., Barrick, M. and Barret, G.W. Fundamentals of Ecology (5th Ed).Thomson Brooks/Cole Publisher, California, 2005.
15. Pandey, B.N. and Jyoti, M.K. Ecology and Environment. APH Publishing Co-operation, New Delhi, 2012.
16. Primak R.B (2014) Essentials of Conservation biology, Sinauer Publishers, 6th edition
17. Rana, S.V.S. Essentials of Ecology and Environmental science (5th Ed), PHI Learning Pvt. Ltd, 2013.
18. Sharma, P.D. Ecology and Environment. Rastogi Publications. New Delhi, 2009.
19. Valdiya, K.S. (2013). Environmental Geology: Ecology, Resource and Hazard Management - by 2nd Edition : Mc Graw Hill Education

Course Type: Discipline Specific Elective

Course Code: MSBODE306T

Course Title: Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution)

Credits-4

COURSE OBJECTIVES:

The objective of the course is to provide detailed understating of various aspects of environmental pollution. The course has been designed to acquaint students with different type of pollution such as soil, water, marine and **Solid Waste Pollution**, effect of marine pollution on flora and fauna. To know about the responsibilities of authorities and Legislation on management and handling of municipal solid wastes

COURSE OUTCOMES:

On completion of the course, the students will be able to:

- Develop concepts environmental pollutants, pollution standards
- Able to correlate environmental pollution and human health
- Impact of chemicals and biomagnifications and its impact on loss of biodiversity
- Classification of waste, sources, characteristics, and impact on environmental health.

Course Code:	Course Title:		
MSBODE306T	**Environmental Pollution**		
Course Credit: **4**		Total contact hours: 60 Hrs	**Allotted hours**
UNIT-I Air and Noise Pollution			**15**

- Environmental Pollution; Classification and nature of Environmental Pollutants; Major sources.

- Impacts of Air Pollution at local regional and global level; Smog, Acid rains, their formation and dispersal in air.
- Air pollution standards; Indoor and outdoor air pollution; Vehicular air pollution; Air pollution episodes and disasters.
- Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones.
- Air and noise pollution abatement with plants, Green Belts.

UNIT II: Soil And Water Pollution: **15**

- Sources and types of soil and water pollutants; Radioactive pollutants, their life time and disposal
- Point and non-point sources of water pollution, major types of water pollutants, Pollution in fresh water bodies, ponds, lakes, rivers and wells.
- Effects of soil and water pollutants on environment and crop plants, animals, Food chains, microorganism and human health;
- Impact of various activities on soil and water
- Maximum permissible limits of soil and water pollutants
- Land degradation, Causes, effects and Remedial measures.

UNIT III: Marine Pollution **15**

- Types, sources and impact. Toxic metal pollution, oil, sewage, pesticide, radioactive pollution and effect of waste disposal on marine ecosystem
- Role of phytoplankton, water blooms and red tide phenomenon.
- Biomagnification: Impact on loss of biodiversity of microbes, animals and plants.
- Effect of marine pollution on wetlands, mangrove and coral reefs; Need for its conservation, Human impact, Threats and conservation measures, CRZ authority

UNIT IV: Solid Waste Pollution **15**

- Solid wastes: Definition, types (Hazardous nonhazardous), Municipal and Industrial solid wastes. Sources, characteristics and impact on environmental health.
- Waste generation rates, Concepts of waste reduction, the three ‘R’s - Reduction, Reuse and recycling.
- Collection, Handling, segregation and transport and storage of municipal solid wastes
- Responsibilities of Municipal authorities, state and Central control Boards, Management of municipal solid waste (as per the existing MSW rule).

- Legislation on management and handling of municipal solid wastes and hazardous wastes.

➢ Besides theory and practical students have to participate in the field/industrial visits at different sites. Field study for acquaintance with plants in their natural habitat and also in different phytogeographical regions and have to submit the Field report

Reference Books:

1. Coleman, D.C., Crossley, D. A. and Handrix, P. F (2004) *Fundamentals of Soil Ecology*, 2nd edition, Elsevier academic press.
2. De, A. K. (1994) *Environmental Chemistry*, Wiley Eastern publication.
3. Hynes, H. B. N. (1978) *Biology of polluted water*, 1st edition, Liverpool University Press.
4. Mukherjee, B. (2000*) Environmental management: Basic and applied aspects of management of ecological environmental system*, 1st edition, Vikas Publication House.
5. Yadav, P. R., and Mishra, S. R. (2004) *Environmental biology*, Discovery publication, New Delhi.
6. Jeremy, C., Tiwary, A. and Colls, J. (2009). Air pollution: measurement, modeling and mitigation, 3rd Edition, Crc Press, USA.
7. Clarke A. G. (1997). Industrial air pollution monitoring: gaseous and particulate emissions, Springer, USA.
8. Kenneth Jr., W., Davis, W. T., Warner C. F. (1998). Air pollution and its origin and control, 3rd edition, Prentice Hall, USA.
9. Cheremisinoff , N. P. (2002). Handbook of air pollution prevention and control, Butterworth-heinemann Publishers, UK.
10. Rao, C.S. (2006). Environmental pollution control engineering, New Age International Publishers, New Delhi.
11. Vallero, D. A. (2007). Fundamentals of air pollution 4th edition, Academic Press, USA.
12. Wang, Lawrence K. Wang, Lawrence K. Pereira Norman C. (2004). Advanced air and noise pollution control.
13. Industrial Noise Control- Bell & Bell

Course Type: Discipline Specific Elective

Course Code: MSBOPR305P and MSBOPR306P

Course Title: Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution)

Credits-4

Research Project MSBOPR305P and MSBOPR306P

Objectives of the Course: As the part of discipline specific elective course plan, the III and IV semester is allotted for doing research on subject area related to Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution) or any other related area in consultation with the research supervisor allotted to the student. Before the start of the research project, the students have to undergone Practical training on the basic experiments related to Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution) under the guidance of the respective supervisor. This is to ensure confidence in handling the methodological part of the project work.

Practical training on the basic experiments related to Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution) **MSBOPR305P Total credits -02**
Objectives of the Course: The objective of the programme is for evaluating the expertise and on hands-on experience of the student in handling research problems independently in the areas of molecular biology and genetic engineering. Prior to the lab work, the student has to do Practical training on the basic experiments related to Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution).

Presentation of the Research proposal **MSBOPR306P Total credits- 02**
Objectives of the course. In the first phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the back ground of the work, detail review of literature, Objectives and methodology to be used and the expected outcomes of the research proposal

Course Code:	Course Title:
MSBOPR305P	**Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution)** Practical training on the basic experiments related to Ecology, Environmental Botany and Biotechnology

Course Credit: **2** Total contact hours: 60 Hrs

1. Comparative study of physic-chemical parameters: colour, odour, turbidity, temperature, pH, conductivity of water samples collected from polluted and non-pollutes sites
2. Dissolved oxygen of water samples collected from polluted and non-pollutes sites
3. Comparative study of Biochemical Oxygen Demand Value from polluted and non-pollutes sites.
4. Comparative study of Chemical Oxygen Demand Value for Industrial Waste effluent collected from any two sites
5. Phytoplankton - collection, estimation, classification and diversity
6. Composting/Vermicomposting Experiments for the management of solid organic waste (1P)
   Field Visits:
   Study visits to CETP (MIDC, Mahad, Lote, etc.) and Industries, MPCB, NEERI, laboratories, Mun. Water Works (Bhandup), Sewage Treatment Plant etc.
   A field visit to sites of pollution and collection of samples and waste water treatment plants/normal & secured landfill site/biological composting/vermin-composting units, estuarine habitat: Field report submission

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources

Course Code:	Course Title:
MSBPR306P	**Ecology, Environmental Botany and Biotechnology-II (Environmental Pollution)**

Course Credit: **2** Total contact hours: 60 Hrs

Project Work

In the first phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the back ground of the work, detail review of literature, Objectives and methodology to be used and the expected outcomes of the research proposal

Course Type: Generic Elective Course

Course Code: MSBOGE301T

Course Title: Environmental Impact Assessment

Credits-2

Course Objectives:

This paper is an introduction to EIA, a systematic process that examines the environmental consequences of development actions, in advance. This course also develop a methodical approach on assessment of environmental impacts due to developmental activities and a conceptual outlook on sustainable development and impart knowledge on Environmental management and Environmental Impact Assessment.

Course Outcomes:

- Knowledge on prediction and assessment of environmental impacts due to developmental activities.
- Concepts on various environmental impact assessment methodologies.
- carry out scoping and screening of developmental projects for environmental and social assessments
- explain different methodologies for environmental impact prediction and assessment
- evaluate environmental impact assessment reports

Course Code:	Course Title:
MSBOGE301T	**Environment Impact Assessment**

Course Credit: **2** Total contact hours: 30 Hrs

UNIT - I Environment Impact Assessment: 15

- Environment Impact Assessment (EIA) - Principles, Origin, development, types, issues, problems and limitations, environmental risk assessment, environmental management plan, environmental impact statement (EIS), Strategic Environmental Assessment (SEA), Existing EIA guidelines and notifications.
- EIA/EMP/Public hearing, terms of reference (TOR), expert appraisal committee for evaluation of the different types of projects/ activities
- Role of expert appraisal committees (EAC, SEIAA) for evaluation of different types of project.

UNIT – II EIA Methodology 15

- Components of EIA, EIA methodology – project screening, scoping, base line data, impact identification, prediction, evaluation, mitigation.

- Assessment techniques – cost benefit analysis, analysis of alternatives, methods of prediction matrices, networks, checklists and overlays
- Assessment of impacts – air, water, soil, noise, biological, social, cultural, economical, environmental factors.

Reference books:

1. Anjaneyulu, Y. Environmental Impact Assessment Methodologies, by B.S. Publication, Sultan Bazar, Hyderabad.
2. Bhatia, H.S., Environmental Pollution and Control, – Galgotia Publication (P) Ltd, Delhi
3. Blaikie, P., Cannon, T., Davis, I. and Wisner, B. (2003). At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd ed.).
4. Abington. Routledge. Brown, K. (2015). Resilience, Development and Global Change. Routledge, London.
5. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York.
6. Fischer, T. B. (2007). Theory and Practice of Strategic Environmental Assessment, Earthscan, London.
7. Glasson, J. Therivel, R. and Chadwick, A. (2006, 2013) Introduction to Environmental Impact Assessment. Routledge, London. 2006.
8. Grumbine, R. E. and Pandit, M.K. (2013). Threats from India's Himalaya dams. Science. 339:36-37.
9. John G. Rau and David C Hooten "Environmental Impact Analysis Handbook", McGraw Hill Book Company, 1990.
10. Kulkarni, V. and Ramachandra, T.V. Environmental Management. Capital Pub. Co., New Delhi. 2006.
11. Lawrence, D. P. (2003) Environmental Impact Assessment: practical solutions to recurrent problems, John Wiley & Sons, Hoboken NJ.
12. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London.
13. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford.
14. Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK 2005.
15. Routledge. Morris. P. and Therivel. R. (2001). Methods of environmental impact assessment, 2nd Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller and G. Wood, p. 381-401.

16. Shukla, S.K. and Srivastava, P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.
17. Suresh K. Dhaneja : Environmental Science and Engineering, by – S. K. Katania & Sons Publication., New Delhi
18. Therivel, R. and Partidario, M. R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London.
19. Vanclay, F. and Bronstein, D. A. (1995) (eds) Environmental and Social Impact Assessment, Wiley & Sons, Chichester
20. Wood, C. (2003) Environmental Impact Assessment – A Comparative Review, Prentice Hall, London.

Course Type: Skill Enhancement Compulsory Course

Course Code: MSBOSC301T

Course Title: Science Communication

Credits-2

Course Objectives:

The will help the students to craft and style the scientific writing and make it easy. Unfortunately, scientific writing is hard work. The best scientific writers struggle with every paragraph, every sentence, and every phrase. They write, then rewrite, and then rewrite again. Scientific writing is a craft, a craft you continually hone.

Course Learning Outcomes:

The students will be learning

1. What are the tools in scientific writing? From where to start writing if you wish to communicate your research.
2. How to prepare a good research manuscript?
3. How to communicate the research manuscript?

Course Code:	Course Title:
MSBOSC301T	**Science Communication**

Course Credit: **2** Total contact hours: 30 Hrs

Unit I Tools And Techniques Of Communicating Science **15 Hrs**

- The Standards of a Scientific Paper
- Scientific Words, Sentences, and Paragraphs Writing
- Scientific Text
- Presenting Numerical Data
- Constructing Scientific Figures
- Word usage in Scientific writing
- Guidelines for effective discussion sections in scientific reports
- Preparing the reference section (software based)

UNIT II Writing A Research Paper **15 Hrs**

- Writing During Research
- Composing the Sections of a Research Paper
- Preparing a Manuscript for Submission
- Choosing a Journal
- A Final Rewrite
- Preparing and Submitting the Manuscript
- Responding to Editors and Referees

Suggested readings

1. Michael Jay Katz:From Research to Manuscript A Guide to Scientific Writing ISBN 978-1-4020-9466-8 e-ISBN 978-1-4020-9467-5 Library of Congress Control Number: 2008940867 © 2009 Springer Science

2. Scientific writing Booklet Compiled by Marc E. Tischler, Ph.D. Department of Biochemistry & Molecular Biophysics University of Arizona

SEM IV

Course Type: Core Compulsory

Course Code: MSBOCC401T

Course Title: Instrumentation and Techniques-II

Credits-4

Objectives:

The course will also help the students to learn the theory and concepts and develop their practical skills to:

- Use the contemporary tools and techniques required in experiment, research and development and also to develop analytical skills of the students which are required.
- Provide intensive practical training on modern instrumentation and analytical techniques for environmental analyses.
- Prepare students for successful career in education, research, industries etc.

Outcome:

After completion of the program, the students have:

- Acquire the knowledge of different instruments and its utilities
- Capable of executing short research projects incorporating various tools and techniques
- Tracer techniques & PCR, Nanotechnology & IPR

Course Code: MSBOCC401T

Course Title: Instrumentation and Techniques - 2

Course Credit: 4 **Total contact hours: 60 Hrs** **Allotted hours**

Unit I: Centrifugation **15**

- Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -
- Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Unit II: Chromatography **15**

- General Principle of chromatography.
- Techniques and applications of Ion exchange, Affinity Chromatography& HPLC
- Application of HPTLC, HPLC, Gas liquid chromatography in validation of herbal drugs

Unit III: Tracer techniques & PCR **15**

- Pattern and rate of radioactive decay, Units of radioactivity, Stable Isotopes
- Principle, instrumentation & technique: Geiger-Muller counter, Liquid scintillation counters & Autoradiography
- Applications of isotopes in biology: Tracer techniques & Autoradiogrpahy

- PCR and its applications

Unit IV: Nanotechnology & IPR **15**

- Synthesis of nanoparticles using biological samples.
- Characterization of nanoparticles (FTIR, SEM, TEM, STEM, Scanning Tunneling Microscope, Atomic Force Microscope, UV-Vis,).
- Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; IP as a factor in R&D

Reference Books

- Bauman R.P. Absorption Spectroscopy. John Wiley, New York Dixon R.N. Spectroscopy and Structure. Mathuen, London Sacks R.D. Emission Spectroscopy. John Wiley, New York
- Pesez M and Bartos J. Colorimetric and Fluorometric Analysis of Organic Compounds and drugs, Dekker, New York. Becker R.S. Theory and interpretation of fluorescence and phosphorescence, Wiley interscience, New York.
- Guilbault G.G. Practical Fluorescence: Theory, methods and Techniques. Dekker, New York.
- Dean J. and Rains T. Flame emission and atomic absorption. Dekker, New York. Brech F. Analysis in instrumentation. Vol. 6. Plenum, New York.
- Bell R. J. Introductory Fourier Transform spectroscopy. Academic Press, New Yrk. Colthup N.B., Daly L.H. and Wiberley S.E. Introduction to Infra-red and Raman Spectroscopy 2nd Ed. Academic Press. New York.
- Kolthoff I.M. and Elving P.J. Treatise on analytical Chemistry, Wiley Interscience, New York.
- Williams D.A.R. and Mowthorpe D.J. Nuclear Maganatic Resonance Spectroscopy. John Wiley, New York.
- Watson I.J. Introduction to Mass spectroscopy, Raven, New York. Giddings J.C. Principles and Theory, Dynamics of Chromatogtraphy Part I Dekker, New York.
- Grob R.L. Modern Practices of Gas Chromatography. 2nd Ed. John Wiley, New York.
- Simpson C.F. Techniques in liquid chromatography, Wiley-Heyden, New York.
- Horvath C. HPLC Vol.I Academic Orlando.
- F.L. Fritz J.S., Gjerde D.T. and Pohlandt C. Ion chromatography,
- A. Huthig, Heidelberg Yau W. W., Kirkland J.J. and Bly D.D. Modern size exclusion chromatography, Wiley Interscience, New York. Bailey P.L. Analysis and ion selective electrodes 2nd Ed.
- Heyden, London. Bates R.G. Determination of pH: Theory and Practices, 2nd Ed. John Wiley, New York.
- Willard H.F., Merritt L.L., Dean, J.A. and Settle F.A. Instrumental Method of analysis. CBS Publishers and distribution, New Delhi
- Sharma, B.K. Principal of analytical chemistry, Merut Publication, Merut.

- Hames B.D. and Rickwood D. Gel electrophoresis of Proteins: A practical Approach 2nd Ed. IRL Press, Oxford.
- Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989
- Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983
- Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H. , John Wiley, New York, 2001
- Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
- Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003
- Bioinformatics and Molecular Evolution – Higgs PG and Attwood, TK
- An Introduction to Biometry- A. M. Mungikar
- Statistical methods for Agricultural workers- Panse V. G. and Sukhatme
- A Textbook of Agricultural Statistics by R. Rangaswamy
- Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983

Course Type: Core Compulsory

Course Code: MSBOCC401P

Course Title: Instrumentation and Techniques-II

Credits-2

Course Code: MSBOCC401P **Allotted hours 60**

Course Title: Instrumentation and Techniques-II MSBOCC401P
Course Credit: 4 **Total contact hours: 60 Hrs**

1. Separation of amino acids by two dimensional chromatography.
2. TLC for separating and identifying biomolecules.
3. Viscosity studies of proteins: standard BSA and varying concentrations of urea
4. Synthesis of nanoparticles and Characterization of nanoparticles by UV spectroscopy
5. Absorption spectra of various compounds to understand λ max, substance absorption.
6. Filing a patent
7. Industrial visit and report submission.

Course Type: Core Compulsory

Course Code: MSBOCC402T

Course Title: Cell and Molecular Biology-II

Credits-4

Objectives:

This paper is designed to provide a detailed account of the structure of the eukaryotic genomes as well as to understand the molecular processes that control the functioning of the genome.

Outcomes (Students will be learning.....)

- The candidates would develop in-depth understanding of the eukaryotic genome organization and function in terms of mechanism of regulation of genes expression and its impact on organism. It would also appraise the students on the utility of such information in control of useful traits and diagnostics.

Course Code:	Course Title:	**Allotted hours**
MSBOCC402T	**Cell & Molecular Biology-II**	

Course Credit: 4 **Total contact hours: 60 Hrs**

Unit I: Protein Synthesis and Processing-I **15 Hrs**

Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination.

Unit II Protein Synthesis and Processing-II **15 Hrs**

Genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.

Unit III Control of Gene Expression at Transcription and Translation Level Phages and Prokaryotes **15 Hrs**

Regulating the expression of phages, Lytic cascade and lysogenic repression in lambda bacteriophage in prokaryotic Constitutive, Inducible and Repressible gene expression, Positive and Negative control of gene expression, Lac, Tryptophan, arabinose operons; Concept of attenuation.

Unit IV Control of Gene Expression at Transcription and Translation Level Eukaryotes **15 Hrs**

Eukaryotic genome organization, Proteins involved in the control of transcription, Protein, protein interactions, Post-translational control, DNA methylation, Cell Signaling, Ligand binding to membrane receptors and its role in regulating transcription, phosphorylation

cascade and amplification of signal. Role of chromatin in regulating gene expression and gene silencing.

Suggested readings

- Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Lodish, H., Berk, A. and 6 more. (2007) Molecular Cell Biology 6th edition. W. H. Freeman.
- Genetics A Molecular Approach Third Edition by Peter J. Russell Benjamin Cummings San Francisco Boston New York
- Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
- Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York.
- Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.
- Freifelder D and Malacinski GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK
- Krebs JE., Kilpatrick ST and Goldstein ES. (2013). Lewin' GENES XI, Jones & Bartlett Learning. Burlington, MA.

Course Type: Core Compulsory

Course Code: MSBOCC402P

Course Title: Cell and Molecular Biology-II

Credits-2

	PRACTICALS: Cell and Molecular Biology-II MSBOCC402P	**Allotted hours**
		60
1	Homogenization of leaves, sub-cellular fractionation by differential centrifugation, chloroplast purification, SDS-PAGE analysis of chloroplast proteins.	
2	Isolation of RNA from plant and separation using AGE	
3	Polymerase Chain Reaction and analysis by agarose gel electrophoresis	
4	Preparation of culture medium, stock solutions and growth curve, determination of viable cells, determination of cell number.	
5	Determination of colony forming units (CFUs) using haemocytometer, dimensions of microbes using ocular- and stage-micrometer	
6	2D gel Electrophoresis	

Course Type: Discipline Specific Elective

Course Code: MSBODE401T

Course Title: Plant Physiology, Biochemistry and Phytochemistry-III- Plant Biochemistry-II

Credits-4

Objectives:

Outcomes (Students will be able to…..)

- Understand lipid structures and metabolism
- Biochemistry of amino acids
- Get an overview of PCD
- Understand modulation of plant genomes by natural PGRs

Course Code:	Course Title:	Allotted hours
MSBODE401T	Plant Physiology, Biochemistry & Phytochemistry-III Plant Biochemistry-II	
Course Credit: 4	Total contact hours: 60 Hrs	

Unit 1: Lipid Metabolism **15**

- Synthesis and Function of Lipids
- Structural & Storage lipids,
- Omega fatty acids,
- beta oxidation of odd and even carbon containing fatty acids

Unit II: Amino Acid Metabolism **15**

- Biosynthesis of following Amino Acids
  - Proline
  - Glycine
  - Aspergine
  - Tryptophan,
  - Phenylalanine
- Regulation of amino acid biosynthesis.

Unit III: Senescence and Cell Death **15**

- Types of cell death
- PCD during seed development and germination
- Cell death during the development of secretory bodies, defensive structures and organ shapes
- PCD during reproductive development
- Senescence and PCD in the terminal development of leaves and other lateral organs
- Pigment metabolism in senescence
- Energy and oxidative metabolism during senescence

Unit IV: MODULATION OF PLANT GENOME BY PGR's **15**

Modulation of plant genomes by natural PGRs-

- Auxins
- GA
- Cytokinins
- Ethylene
- ABA.

Overview of new PGR's

Suggested readings

- Goodwin and Mercer Plant Biochemistry
- Lehninger and Nelson D.L. Principles of Biochemistry
- Gerald Karp (2010) Cell & Molecular Biology: Concepts & Experiments
- Taiz and Zeiger Plant Physiology
- Gerald F. Combs & James P. McClung (2017) The Vitamins: Fundamental Aspects in Nutrition and Health
- Rajan Katoch (2011) Analytical Techniques in Biochemistry & Molecular Biology
- Stryer L. Biochemistry
- Lodish **H.** and Dameu J. Molecular Cell Biology
- Dey PM and Harbome JB Plant Biochemistry
- Buchanan (2015) Biochemistry & Molecular Biology of Plants
- R. Smith et al. (etis.), Plant Hormone Signal Perception and Transduction, 1--6. 1996 Kluwer Academic Publishers.
- Peter J. Davies, Plant Hormones, Physiology, Biochemistry and Molecular Biology
- Peter J. Davies, Plant Hormones: Biosynthesis, Signal Transduction, Action, 3rd Edn

Course Type: Discipline Specific Elective

Course Code: MSBODE402T

Course Title: Plant Physiology, Biochemistry and Phytochemistry-IV- Phytochemistry-III

Credits-4

Objectives:

Outcomes (Students will be able to…..)

- Understand physiological, morphological & Biochemical aspects of Stress
- Understand how plants survive under abiotic stresses
- Understand various types of phytoremediation, the mechanism involved & role of genetic engineering for development of plants resistant to stress
- Understand the physiological & morphological changes during fruit ripening which will ultimately help to understand pre & post-harvest technology of fruits

Course Code: MBODSE4T	Course Title: Plant Physiology, Biochemistry & Phytochemistry-IV, Applied Plant Physiology	Allotted hours

Course Credit: 4 **Total contact hours: 60 Hrs**

Unit I: Stress Physiology: Drought **15**

- Drought Stress in Plants: Causes, Effects and Management
- Mechanisms of Drought Tolerance and Resistance

Unit II: Stress Physiology: Salinity **15**

- Physiological Constraints Imposed by Salinity
- Mechanism of Salt resistance- salt avoidance and tolerance

Unit III: Phytoremediation **15**

- Types of Phytoremediation- Advantages & limitations,
- Remedial measures- Rhizosphere based & Plant based, Hyper accumulators
- Role of genetic engineering & various enzymes in phytoremediation

Unit IV: Post- h arvest Technology **15**

- Climacteric and Non-climacteric Ripening
- Cellular and metabolic aspects of fruit ripening
- Cell wall metabolism
- Ethylene and the control of fruit ripening
- Post-harvest technology of fruits

Suggested readings

- Gregory A. Tucker (2013) The Molecular Biology and Biochemistry of Fruit Ripening
- Pravendra Nath (2013) Fruit Ripening Physiology, Signalling and Genomics
- Sergey Shabala (2017), Plant Stress Physiology, 2nd Edition,
- M.A. Hossain et al. (eds.) 2016, Drought Stress Tolerance in Plants, Vol1, Springer
- Jacob Levitt, Responses of Plants to Environmental Stresses: Water, radiation, salt, and other
- Matthew A. Jenks & Paul M. Hasegawa 2014, Plant Abiotic Stress Second Edition,
- Ram ChandraN. K. Dubey Vineet Kumar Phytoremediation of Environmental Pollutants
- M. Ashraf· M. Ozturk · M.S.A. Ahmad: Plant Adaptation and Phytoremediation
- Abid Ali Ansari Phytoremediation: Management of Environmental Contaminants

Course Type: Discipline Specific Elective

Course Code: MSBOPR401P and MSBOPR401P

Course Title: Research Project

Credits-4

Research Project MSBOPR401Pand MSBOPR402P

Objectives of the Course: As the part of discipline specific elective course plan, the III and IV semester is allotted for doing research on subject area related to **Plant Physiology, Biochemistry and Phytochemistry** or any other related area in consultation with the research supervisor allotted to the student. Before the start of the research project, the students have to undergone Practical training on the basic experiments related to **Plant Physiology, Biochemistry and Phytochemistry** under the guidance of the respective supervisor. This is to ensure confidence in handling the methodological part of the project work.

Practical training on the basic experiments related to **Plant Physiology, Biochemistry and Phytochemistry MSBOPR403P Total credits -02**
Objectives of the Course: The objective of the programme is for evaluating the expertise and on hand experience of the student in handling research problems independently in the areas of molecular biology and genetic engineering. Prior to the lab work, the student has to do Practical training on the basic experiments related to **Plant Physiology, Biochemistry and Phytochemistry**

Presentation of the Research proposal **MSBOPR404P Total credits- 02**
Objectives of the course. In the Second phase of the research project the student will make a PPT presentation of the research outcomes before the board of examiners emphasizing the objectives of the work achieved, Results and Discussion and Bibliography. The student has to submit a bind Dissertation of the entire research work

Course Code:	Course Title:	Allotted hours
MSBOPR403P	**Plant Physiology, Biochemistry & Phytochemistry-III**	

Course Credit: **2** **Total contact hours: 60 Hrs**

1. Preparation of extracts by
    - Maceration
    - Percolation,
    - Decoction,
    - Reflux,
    - Distillation,
    - Soxhlet extraction,
    - Sonication
    - Enzyme Assisted Extraction

2. Extraction & separation of Glucosinolates from *Brassica* sps
3. Extraction & separation of Piperine from *Piper longum*
4. Extraction & separation of lycopene from *Lycopersicum*
5. Measurement and Characterization of Chlorophylls and Carotenoids

Course Code:	**Course Title:**	**Allotted hours**
MSBOPR404P	**Plant Physiology, Biochemistry and Phytochemistry**	
Course Credit: **2**	Total contact hours: 60 Hrs	

Project Work

In the Second phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the objectives of the work achieved, Results and Discussion and Bibliography. The student has to submit a bind Dissertation of the entire research work

Course Type: Discipline Specific Elective

Course Code: MSBODE403T

Course Title: Molecular Biology, Cytogenetics and Biotechnology-III (Immunology and Techniques)

Credits-4

Objectives:

The objective of the present course content is to provide a foundation and background in Immunology, Techniques used in biotechnology, molecular mapping of plant genomes and antisense technology

Course Learning Outcomes:

The students will be learning

1. Current state of knowledge about the Immunology.

2. What are the techniques of nucleic acid manipulation? How DNA is sequenced?

3. What is the role of molecular maps in crop improvement? How genomes are mapped?

4. Concept of DNA bar coding

5. What is anti-sense technology? RNA interference therapeutics, DNA protein interaction studies

Course Code:	**Course Title:**	**Allotted hours**
MSBODE403T	**MOLECULAR BIOLOGY, CYTOGENETICS & BIOTECHNOLOGY-III (Immunology and Techniques)**	
Course Credit: 4	**Total contact hours: 60 Hrs**	

Unit I : Immunology **15**

Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell mediated immune responses.

Unit II: Basic Techniques in Biotechnology **15**

Basic Techniques: Isolation Handling and quantification of Nucleic acids, DNA (genomic & plasmid) & RNA agarose gel electrophoresis, pulse field gel electrophoresis. Preparation of labeled DNA probes, Southern blotting. Northern blotting, DNA sequencing – Maxan Gilbert & Sanger Methods. DNA finger printing. Transformation, Transfection & generation of deletions, gene knock out.

Unit III: Molecular Maps of Plant Genomes **15**

Molecular maps of plant genomes: RFLP Genetic maps in plants, Linkage of major genes and QTLs to RFLPs, Uses of RFLPs maps, Cytogenetic RFLP maps using aneuploids, RAPDs and SSRs. Crop improvement and gene tagging, physical maps using in- situ hybridisation (ISH). Molecular maps in Yeast and other fungi. Genome mapping by conjugation.

Unit IV: Antisense Technology **15**

Antisense technology - Antisense oligonucleotides, RNA interference (RNAi), RNAi therapies Analysis at the level of gene transcription – Northern blot, RNase protection assay. Analysis of DNA protein interactions: Electrophoretic mobility shift assay (EMSA), DNase I footprinting, Chromatin immuno-precipitation assay. Analysis of protein-protein interactions- Pull-down assay, Yeast two hybrid assay, Co-immunoprecipitation assay, Fluorescence resonance energy transfer (FRET).

Suggested readings

- Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Lodish, H., Berk, A. and 6 more. (2007) Molecular Cell Biology 6th edition. W. H. Freeman.
- I-Genetics A Molecular Approach Third Edition by Peter J. Russell Benjamin Cummings San Francisco Boston New York
- Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
- Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York.
- Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.
- Freifelder D and Malacinski GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK
- Krebs JE., Kilpatrick ST and Goldstein ES. (2013). Lewin' GENES XI, Jones & Bartlett Learning. Burlington, MA.

Course Type: Discipline Specific Elective

Course Code: MSBODE404T

Course Title: Molecular Biology, Cytogenetics and Biotechnology-IV (Applications of rDNA Technology and Nanotechnology)

Credits-4

Objectives:

The objective of the present course content is to provide a detailed application of recombinant DNA technology. Plant secondary metabolite production and its application in pharmacy. Transgenic plant production for Value addition traits. Nanotechnology and industrial application.

Outcomes:

The students will be learning

1. Current state of knowledge about the applications of recombinant DNA technology in medicine and agriculture.

2. Plant secondary metabolites as useful drugs in the pharmacy industry.

3. Transgenic plants tolerant to abiotic stresses such as, drought, cold, salt and metal. Edible vaccines and production of plants with enhanced modified flower pigments.

4. Genome editing through CRISPR/Cas system

5. What is Nanotechnology? What are the properties of nanomaterials? How nanomaterials are characterized? What are the applications of nanomaterials in biology?

Course Code:	**Course Title:**	**Allotted hours**
MSBODE404T	**MOLECULAR BIOLOGY, CYTOGENETICS & BIOTECHNOLOGY-IV (Applications of rDNA technology and nanotechnology)**	

Course Credit: 4 **Total contact hours: 60 Hrs**

Unit I: Applications of Recombinant DNA Technology **15**

Applications of Recombinant DNA Technology: In Medicine: Molecular diagnostics, vaccines, drugs, gene therapy. In Agriculture: Transgenic plants, insecticide, herbicide resistant plants. In Industry: Commercially available recombinant products, transgenic animals. Introduction to genome editing by CRISPR-CAS and its applications in plant genome editing.

Unit II: *In Vitro* Technology and Pharma Industries **15**

Plant Secondary metabolites, In vitro extraction isolation of bioactive compounds from plants used as drugs in pharma industries such as antimalarials e.g. artemisinin, anticancerous, taxol, psoralen, spilanthol, connessine, antidabetics steviosides, rebaudiosides etc. Knowledge of biosynthetic pathways and Elicitation of compounds through abiotic and biotic elicitors, hairy root culture and their scaling up through bioreactors

Unit III: Transgenic Plants **15**

Transgenic plants tolerant to abiotic stresses such as, drought, cold, salt and metal. Comparison of Ist, 2nd and 3rd generation transgenic and their advantages and constraints. Transgenic plants with nutritionally rich traits (Value addition traits) such as golden rice, maize, tomato, etc. Edible vaccines, plants with enhanced modified flower pigments.

Unit IV: Nanotechnology and Industrial Applications **15**

Introduction to Nanotechnology and overview of nanoscale materials; top-down and bottom-up approach, methods of nanoparticle synthesis, its characterization and analysis of nanoparticles by different techniques such as UV-Visible spectroscopy, Particle Size analyser, SEM, TEM, X-RD, FTIR. Synthesis of Nanoparticles by Biological system, in general and Plants in particular, Extracellular and intracellular biosynthesis with a case study of silver and gold nanoparticles, Applications of bionanotechnology in various fields.

Suggested readings

- Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Lodish, H., Berk, A. and 6 more. (2007) Molecular Cell Biology 6th edition. W. H. Freeman.
- I-Genetics A Molecular Approach Third Edition by Peter J. Russell Benjamin Cummings San Francisco Boston New York
- Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
- Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York.

- Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.
- Freifelder D and Malacinski GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK
- Krebs JE., Kilpatrick ST and Goldstein ES. (2013). Lewin' GENES XI, Jones & Bartlett Learning. Burlington, MA.

Course Type: Discipline Specific Elective

Course Code: MSBOPR403P and MSBOPR404P

Course Title: Research Project

Credits-4

Research Project MSBOPR403Pand MSBOPR404P

Objectives of the Course: As the part of discipline specific elective course plan, the III and IV semester is allotted for doing research on subject area related to Cytology, Molecular biology and Plant Biotechnology or any other related area in consultation with the research supervisor allotted to the student. Before the start of the research project, the students have to undergone Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology under the guidance of the respective supervisor. This is to ensure confidence in handling the methodological part of the project work.

Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology **MSBOPR403P Total credits -02**
Objectives of the Course: The objective of the programme is for evaluating the expertise and on hand experience of the student in handling research problems independently in the areas of molecular biology and genetic engineering. Prior to the lab work, the student has to do Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology.

Presentation of the Research proposal **MSBOPR404P Total credits- 02**
Objectives of the course. In the Second phase of the research project the student will make a PPT presentation of the research outcomes before the board of examiners emphasizing the objectives of the work achieved, Results and Discussion and Bibliography. The student has to submit a bind Dissertation of the entire research work

Course Code:	Course Title:	Allotted hours
MSBOPR403P	**MOLECULAR BIOLOGY, CYTOGENETICS & BIOTECHNOLOGY-I** **Practical training on the basic experiments related to Cytology, Molecular biology and Plant Biotechnology**	

Course Credit: 2 **Total contact hours: 60 Hrs**

1. Synthesis of Silver Nanoparticles using plant, bacterial and fungi and Characterization of Silver nanoparticles using UV-Vis spectrophotometer
2. Determination of Molecular weight by viscometry method
3. Isolation and separation of cell organelles
4. MTT assay for cell viability and growth
5. HPLC demonstration
6. HPTLC Demonstration
7. Particle Size Analyzer Demonstration
8. Enhancement of secondary metabolites using elicitor strategies

Course Code:	Course Title:
MSBPR404P	**MOLECULAR BIOLOGY, CYTOGENETICS & BIOTECHNOLOGY-II**

Course Credit: 2 **Total contact hours: 60 Hrs**

Project Work	Allotted **hours**
In the Second phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the objectives of the work achieved, Results and Discussion and Bibliography. The student has to submit a bind Dissertation of the entire research work	

Course Type: Discipline Specific Elective

Course Code: MSBODE405T

Course Title: Ecology, Environmental Botany and Biotechnology-III (Conservation, Policies and Practices)

Credits-4

Objectives:

The objective of the course is to develop understanding of **conservation, policies & practices**. The course will provide students a fair understanding of various energy resources, energy situation, **renewable and non-renewable sources of energy, soil and water conservation.** Students will be educated on **management and Environmental Policies & Practices. Students will learn about** water-harvesting and conservation. They will get knowledge on principles and technologies of bio-energy for energy and environmental conservation.

Outcomes:

After completion of this course, the students will be able to:

- Acquire the knowledge of growing energy needs and use of alternate energy sources
- They will learn importance and scope of soil and water conservation
- Groundwater Pollution and its control measures
- Ground water recharge and watershed management
- Important Conventions and Protocols
- Legal Provisions for protecting environment

Course Code: MSBODE405T	**Title: Conservation, Policies & Practices**	Allotted **hours**

Course Credit: 4 **Total contact hours: 60 Hrs**

Unit 1: Renewable and Non-Renewable Sources of Energy **15**

- Energy utilization and causes of Growing Energy Needs – Population, Industries.
- Renewable and Non-Renewable Sources, use of Alternate Energy Sources, Wind Energy, Solar Energy, Water as Source of Energy.
- Biofuels Production, use and sustainability
- Nuclear and geothermal energy, Limitations in harvesting.
- Impact of increasing energy consumption.

Unit 2: Soil and Water Conservation: **15**

- Types of erosion, their causes. Rainfall, runoff and sedimentation relationships and their measurement.
- Groundwater pollution and control measures

- Soil erosion control measures - biological and engineering including stream bank protection-vegetative barriers, contour bunds, contour trenches, contour, pitching, contour ditches, terraces, outlets and grassed waterways.
- Wind Erosion process - design for shelter belts and wind brakes and their management.
- National River Conservation Plan (NRCD); Ganga Action Plan
- Coastal areas – Severity and consequences, Conservation measures, Mangrove conservation / plantation.

Unit 3: Water Shed management **15**

- Concept of watershed; water harvesting and moisture conservation; role of mini-forests and forests in overall resource management
- Rainwater harvesting and artificial recharge, ground water recharge and watershed management;
- Role of integrating plantation forests, horticultural crops, field crops, grass and fodders
- Use of GIS in planning and development of watersheds and water resources

Unit 4: Environmental Policies & Practices **15**

- Role of National and International Organizations in Conservation with reference to UNDP, WWF, World Bank, BNHS, MoEFCC, DST, DBT, CSIR, CPCB, State PCBs, Municipal Corporations Agenda 21, NGOs, IBGP, TRIPS.
- Legislation Aiming at Conservation (Objectives), Environment Protection Act (EPA) 1986, Forest Conservation Act 1980, Wildlife protection Act 1972, Coastal Regulation Zones (CRZ) and modifications, Protected Areas Network (PAN)
- Conventions: Earth summit, Vienna Convention, Ramsar Convention,
- Protocol: Montreal protocol, Cartagena protocol
- Constitutional Provisions for protecting environment- Articles 48(A), 51 A (g) The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and Control of Pollution) Act 1974

Reference Books:

- Abbasi, S.A. (2001). Renewable Energy Sources and Their Environmental Impact, 1st ed. Ashok K. Ghosh, Prentice Hall of India
- Basudeb Bhatta, (2011). Remote Sensing & GIS - by Oxford University Press (OUP) Higher Education Division, (Second Edition)
- Garg H.P. and Prakash, J. (1992). Solar Energy Fundamentals and Applications, Tata Mc Graw Hill
- Grigg, Neil S. (2009). Water resources management: Principles, regulations, and cases, McGraw Hill Professional.
- James B. Campbell and Randolph H.Wynne, (2011). Introduction to Remote Sensing - by (5th Edition), The Guiford Press.

- Kumar, H.D. (2001). Forest resources: Conservation and management. Affiliated East-West Press.
- Lal, Banwari and Sarma, P.M. (2011).Wealth from waste: Trends and technologies, TERI
- Prasad, S and Dhanya M.S. (2013). Biofuels, Narendra Publishing house, New Delhi,
- Primak R.B (2014). Essentials of Conservation biology, Sinauer Publishers, 6th edition
- Rai, G.D. (1996). Non Conventional Energy Sources, 4th ed., Khanna Publication.
- Rao, S.and Prulaker, B. (1996). Energy Technology, 1st ed., Khanna Publications.
- Sukhantine, S.P. (1992). Solar Energy: Principles of Thermal Collection and Storage, 2nd ed., Tata Mc Graw Hill

Course Type: Discipline Specific Elective

Course Code: MSBODE406T

Course Title: Ecology, Environmental Botany and Biotechnology-IV (Environmental Pollution)

Credits-4

Objectives:
This course aims to provide the students with an Emerging Environmental Problems and Technology for Pollution Control. The students will get an insight about Wastewater treatment, Bioremediation. The students will be acquainted with Environmental Biotechnology and Agriculture. Further, the students will be familiarized with the solid waste management

Outcomes:
On completion of the course, the students will be able to:

- **Wastewater treatment**
- **Bioremediation**
- Understand the concept of solid waste management
- **Environmental Biotechnology and Agriculture**
- Second generation biofuels (bioethanol, biodiesel, biogas (methane), biohydrogen)

Course Code:	**Title: Technologies for Pollution Control**	Allotted **hours**
MSBODE406T		
Course Credit: 4	**Total contact hours: 60 Hrs**	

UNIT I Wastewater treatment **15**

- Water as a natural resource, Global water inventory and dynamics, Global and Regional hydrological cycles, Interventions in urban areas and impact.
- Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes
- Biodegradation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment
- Treatment schemes for waste water, dairy, distillery, tannery, sugar, paper and pulp industry, antibiotics and fruit-juice manufacturing industries.

UNIT II Bioremediation **15**

- Current remediation practices, benefits of bioremediation
- Biodegradation of xenobiotics in environment, hydrocarbons, oil pollution, surfactants, pesticides, heavy metals

- Bioremediation in mined out area, utilization of fly ash–Sources, Environmental impact and use in remediation.
- Microbial systems for heavy metal accumulation; Biosorption. Evolution of metal tolerance in plants. Bioaccumulation, Biomagnification.
- Application of bacteria and fungi in bioremediation: Microbes in recovery of metal (bioleaching) and oil, Uses, advantages & disadvantages, Role of transgenics in bioremediation (Superbug)

UNIT III SOLID WASTE MANAGEMENT 15

- Solid waste processing technologies: Mechanical and thermal volume reduction.
- Biological and chemical techniques for energy and other resource recovery.
- Composting, vermicomposting and incineration of solid wastes.
- Disposal in landfills – site selection, design, and operation of sanitary landfills, secure landfills & landfill bioreactors, leachate & landfill gas management, landfill closure & post-closure environmental monitoring and landfill remediation.
- Biomedical Waste Management: and its management & disposal and preventive measures
- E-waste and its management

UNIT IV Environmental Biotechnology and Agriculture 15

- Mechanism of biological nitrogen fixation process. study of NIF, NOD and HUP genes in nitrogen fixation process
- Biopesticides: *Bacillus thuringienis*, Bacilo viruses, uses, genetic modifications and aspects of safety in their use.
- Biofungicides: Description of mode of actions and mechanisms (e.g. *Trichoderma*, *Pseudomonas fluorescens*)
- Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), microbial mineralization, Plant growth promoting Rhizobacteria (PGPR) – uses, practical aspects and problems in application

➢ Besides theory and practicals students have to participate in the field/industrial visits at different sites. Field study for acquaintance with plants in their natural habitat and also in different phytogeographical regions and have to submit the Field report

Reference Books:

- APHA (2012) Standard methods for the examination of water and waste water, edn. American Public Health Association, Washington, DC.
- Bhattacharya, B. and Banerjee, R. (2008).Environmental Biotechnology
- Gupta, Vijay Kumar, Tuohy, Maria G. (Eds) Biofuel Technologies- Recent Developments, Springer publication
- Dominik Rutz, Rainer Janseen, Biofuel technology Handbook, WIP Renewable Energies, Germany
- Biotechnology for Solving Agricultural Problems; Danforth & Bakst.

- Brunner, C. R. (1989). Hazardous waste incineration. John Wiley & Sons.
- CPHEEO (2000). Manual on Municipal Solid Waste Management, Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, Govt. of India, New Delhi.
- Crittenden, J. C., Trussell, R. R. and Hand D. W. (2005). Water treatment: principles and design, 2nd edition, Wiley Publishers, USA.
- Das, H. K. (Editor) (2007) Textbook of Biotechnology. 3rd Edition. Wiley India (P) Ltd.
- Dawson, G. W., & Mercer, B. W. (1989) Hazardous waste management. John Wiley & Sons.
- Trivedy R.K. and Arvind Kumar.Ecotechnology for Pollution Control and Environmental Management by
- Ujang, Zaini (Ed.) Municipal wastewater management in developing countries: Principles and Engineering.
- Jarry A. Nathanson, (2003). Basic Environmental Technology, 4th ed , Prentice Hall of India Pvt.Ltd.
- Jeremy, C., Tiwary, A. and Colls, J. (2009). Air pollution: measurement, modeling and mitigation, 3rd Edition, Crc Press, USA.
- Johri, Rakesh (Ed.), (2009) E-waste : Implications, regulations and management in India and Current global best practices, TERI press.
- Khan, I. H., & Ahsan, N. (2012). Textbook of solid waste management. New Delhi: Satish Kumar Jain for CBS Publisher and Distributors.
- Nathanson, J.A. (2014). Basic Environmental Technology: Water supply, waste management and pollution control, Prentice-Hall of India, New Delhi.
- Nicholas P. Cherimisinoff, Biotechnology for Waste and Waste Water Treatment, Prentice Hall of India Pvt. Ltd. (2001).
- Okafor N. (2011). Environmental microbiology of aquatic and waste systems, 1st edition, Springer publication, USA.
- Hester R E (ed.); Roy M Harrison (ed.) (2008) Electronic waste management: design, analysis and application, Cambridge Royal Society of Chemistry.
- Rao, C.S. (2006). Environmental pollution control engineering, New Age International Publishers, New Delhi.
- Reddy, S.M., Srivastava, H.P., Purohit, D.K., and Reddy, S.R.1997.Microbial biotechnology. Scientific Publishers, Jodhpur, India.
- Rosenfeld, Paul E., (2011) Risks of hazardous wastes, Elsevier London.
- Sahai, Sushma (2009) Bio- medical waste management, APH Publishing.
- Solid Waste Management Manual CPCB, New Delhi.
- Tchobanoglous, G., &Kreith, F. (2002). Handbook of Solid Waste Management-Second Edition. New York: McGraw-Hill.
- Wastewater Engineering: Treatment, disposal, Reuse – Metcalf & Eddy Inc.4th ed. TMGHl, New Delhi, 2003.
- Williams, Paul T. (2013) Waste treatment and disposal, John Wiley Publishers

Course Type: Discipline Specific Elective

Course Code: MSBODE405P and MSBODE406P

Course Title: Research Project

Credits-4

Objectives of the Course: As the part of discipline specific elective course plan, the III and IV semester is allotted for doing research on subject area related to **Ecology, Environmental Botany and Biotechnology** or any other related area in consultation with the research supervisor allotted to the student. Before the start of the research project, the students have to undergone Practical training on the basic experiments related to **Ecology, Environmental Botany and Biotechnology** under the guidance of the respective supervisor. This is to ensure confidence in handling the methodological part of the project work.

Practical training on the basic experiments related to **Ecology, Environmental Botany and Biotechnology MSBOPR405P Total credits -02**
Objectives of the Course: The objective of the programme is for evaluating the expertise and on hand experience of the student in handling research problems independently in the areas of **Ecology, Environmental Botany and Biotechnology**. Prior to the lab work, the student has to do Practical training on the basic experiments related to **Ecology, Environmental Botany and Biotechnology**

Presentation of the Research proposal **MSBOPR406P Total credits- 02**
Objectives of the course. In the Second phase of the research project the student will make a PPT presentation of the research outcomes before the board of examiners emphasizing the objectives of the work achieved, Results and Discussion and Bibliography. The student has to submit a bind Dissertation of the entire research work

Course Code: MSBOPR405P

Course Credit: 02 **Total contact hours: 30 Hrs**

1. Working, standardization of flame photometer and plotting calibration curve for metal ions **(1P)**
2. Determination of pH, Electrical Conductivity/salinity and Water Holding Capacity of Different Types of Soil **(1P)**
3. Isolation and enumeration of microbes from environmental samples (air/water/soil) **(2P)**
4. Production of enzymes like cellulose/ proteases/ amylases/ alcohol production (Any one). **(2P)**
5. Sampling and analysis of noise in industrial/ residential/high traffic areas/ commercial zones **(1P)**
6. Study of various meteorological parameters and making of Wind roses **(1P)**

7. Field Visits: Field study for acquaintance with plants in their natural habitat and also in different phytogeographical regions: Field report

Note: changes in the list of experiments may be made from time to time by the department depending on the availability of resources

Course Code: MSBOPR406P **Course Title: Ecology, Environmental Botany and Biotechnology-IV**

Course Credit: 2 **Total contact hours: 60 Hrs**

MSBOPR406P Project Work	Allotted **hours**
In the Second phase of the research project the student will make a PPT presentation of the research proposal before the board of examiners emphasizing the objectives of the work achieved, Results and Discussion and Bibliography. The student has to submit a bind Dissertation of the entire research work	**30**

Course Type: Discipline Specific Elective

Course Code: MSBOSC401T

Course Title: Applied Botany

Credits-4

Course Code: MSBOSC401T Allotted hours

Course Title: Applied Botany

Course Credit: 04 **Total Contact Hours: 30 Hrs**

UNIT-1: Fermentation Technology **15**

- Biotechnological applications of Yeast/Fungi and their derivatives in history: bread making, alcohol production, applications in medical science, bioconversion and bio-ethanol (General account)
- Fermentation process and fermenters types
- Industrial processes- upstream and down-stream processes,
- Industrial producer strains and strain improvement.
  - Use of mutants/ Genetically Modified Microorganisms (GMM) as against Wild type isolates for production.

UNIT-1: Alcohol and Beverage Industry **15**

- Industrial fermentation products and their producer microorganisms.
- Characteristics of important microbes used in Industrial Microbiology.
- Production of alchoholic beverages-beer, wines
- Sources for bioethanol production- sugar crops, starch crops, cellulosic feed stock
- Bioethanol production- sugar-to-ethanol process, starch-to-ethanol process, cellulose-to ethanol process, bio-ethanol form lignocelluloses, distillation to dehydration process, technology applications of bioethanol

UNIT-1: Antibiotic and Organic Acid Industry **15**

Production and their industrial applications of:

- Antibiotics- Penicillins and Cephalospoins,
- Organic acids- production of vinegar and citric acid,
- Industrial enzymes -Cellulase, Amylase,
- Exopolysaccharides : Xylan
- Vitamins and Pigments

UNIT-1: Food Industry and Agriculture **15**

- Microbes exploited commercially- *Saccharomyces, Lactobacillus, Penicillium, Acetobactor, Bifidobacterium, Lactococcus, Streptococcus* etc, in Dairy fermentation and fermented products
- SCP- *Spirulina,* Mushrooms, Agar production.
- Commercial Production of biofertilizers and biopesticides,
- Botanical pesticides- Pyrethrum, Nicotine, Rotenone, Neem, Karanja
- Mass production of phosphate solubilizing bacteria and Mycorrhizae

References:

- A Text Book of Biotechnology. R C Dube
- Advances in Agril. Microbiology by, Oxford and IBH Publication Co, New Delhi N.S. Subbarao,
- Agricultural Microbiology, Oxford and IBH Publication Co. New Delhi. Rangaswamy G. and D.J. Bhagyaraj 1988.
- Biofertilizer Manual 2006 FNCA Biofertilizer Project Group Forum for Nuclear Cooperation in Asia (FNCA)
- Bio-fertilizers in Agriculture and Forestry. N.S. SubbaRao. 1995.
- Biofuel Technologies- Recent Developments, Gupta, Vijay Kumar, Tuohy, Maria G. (Eds) Springer publication
- Biofuel technology Handbook, Dominik Rutz, Rainer Janseen, WIP Renewable Energies, Germany
- Biopesticides for sustainable agriculture: prospects and constraints, Editor(s): Nutan Kaushik
- EnvironmentalBiotechnology-C.F.Foster
- Environmental Biotechnology- W.D.Grant
- Fertilizer control act 1985 Gazette of India
- Insecticide control act 1985 Gazette of India
- Microbes for Sustainable Agriculture Tilak, K.K. Pal, Rinku Dey.
- Soil microorganism. Oxford and IBH Publication Co. New Delhi N.S. SubbaRao.
- Waste water treatment, engineering and Disposal: Metcalf
- Andersen, R. A. (ed.) (2005). *Algal culturing techniques.* Elsevier Academic Press, pp. 578.
- Becker, E. W. (1994). *Microalgae: biotechnology and microbiology.* Cambridge University Press, pp. 293.
- Posten, C. and Walter, C. (eds.) (2012). *Microalgal biotechnology: potential and production.* Walter de Gruyter GmbH, Berlin/Boston, pp. 266.
- Bajaj, Y.P.S., Ed. (1988) Biotechnology in Agriculture and Forestry- vol. 4,Springer-Verlag, Berlin, Heidelberg, New York, Tokyo.

Course Type: Discipline Specific Elective

Course Code: MSBOSC401T

Course Title: Plant Tissue Culture II

Credits-4

Course Objectives:

The objective of the present course content is to provide a foundation and background in cellular entities of plants and animals, cell structure in relation to functions, eukaryotic genome structure (including nuclear and organellar)

Course Learning Outcomes:

The students will be learning

1. Current state of knowledge about the plant cell structure and their turn over, starting from cell wall to chromatin, in relation to their functions.

2. What are the components of endo-membrane systems and mechanisms governing intracellular trafficking in plant cells?

3. What is the role of plant cytoskeleton and accessory proteins in major cellular processes of plants?

4. What are various components of the eukaryotic nuclear and organellar genome, with special reference to their regulatory role

5. What are the principle mechanisms of genome replication, maintenance, function?

Course Code:	**Course Title:**	
MSBOSC401T	**Plant Tissue Culture II**	
Course Credit: **4**	Total contact hours: 60 Hrs	**Alloted hours**
Unit I Protoplast Culture and Somaclonal Variation		**15 Hrs**
Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion- chemical, Viral, electrofussion. Practical application of somatic hybridization and cybridization. Somaclonal variation, its genetic basis and application in crop improvement. Cell/callus line selection for resistance to herbicide, stress and diseases.		

Unit II Hardening And Germplasm Preservation **15 Hrs**

Hardening stages, Role of Polyhouse, Net House, Compost, Chemical fertilizer, Cocopit, Soil in hardening.

Germplasm preservation- Definition, Importance and Methods, In-situ and Ex-situ conservation, Centers of germplasm preservation in India.

Unit III Commercial Floriculture **15 Hrs**

Floriculture — Production of cut flowers and home floriculture. Disease and pest control in gardening- Fungicides and pesticides. Plant growing problems and their control, cold house storage.

Unit IV Commercial Horticulture **15 Hrs**

Propagation of Horticultural crops by tissue culture techniques such as Banana, Sugarcane, Papaya, Mango and some Medicinal and Aromatic plants.

Suggested readings

1. Amritrao, P. V. D. A. Evans, W. P. Sharp and Bajaj Y.P.S. (1990) Handbook of Plant Cell Culture volumes I-V, McGraw Hill Publishing Co., New York.
2. Bhojwani S.S. And Rajdan M.K. (1983). Plant Tissue Culture: Theory and practice.
3. Reinert J.and Bajaj Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, By Springer - Verlag, Berlin.
4. Grierson, D. and Coyey S.N. (1984) Molecular Biology Bllakie Publishers, New York.
5. Gupta P.K. (1995) Elements of Biotechnology, Rastogi and Company
6. Bhojwani S.S. (1991). Plant tissue culture: Application and limitations, Elsevier, Amsterdam.
7. Dixon R.A. and Gonzales, IRL Press, Plant Cell culture: A Practical Approach.
8. Debergth P. C. and Zimmerman (1990): Micro propagation: Kluwer, Academic Publication, Dordrecht.
9. K. Lindsey and M. G. K. Jones (1990): Plant Biotechnology in Agricultural, Prentice Hall, New Jersey.
10. Biotechnology by Satyanarayana U. Books and Allied (P) Ltd., Kolkata, India, 2005.