

# **SYLLABUS**

## **M. Phil. in Botany**

**With effect from**

**2019-20**



**NORTH ORISSA UNIVERSITY**

**SRIRAM CHANDRA VIHAR**

**TAKATPUR, BARIPADA-757003**

## **P.G DEPARTMENT OF BOTANY**

M. Phil. Course in Botany

With effect from 2019-20

1. Candidates securing at least 55% (50% for ST/SC candidates) or equivalent grade in M. Sc. Botany are eligible to apply for admission into the course. Selection of candidates for admission into the course shall be made from the merit list prepared on the basis of viva-voce test after qualifying in written entrance test. Reservation of seats for admission will be as per Government rule.
2. The course is of one year (Two Semesters) duration and consists of theory, laboratory and dissertation works. The theory papers carry 50 marks will be each of 3 hours duration. Examination of practical papers carrying 100 marks will be of 6 hours duration.
3. The course will start at the beginning of the academic session in the month of June or as per the University schedule.
4. The examinations will be held at the end of the academic session in the month of May or as per the University schedule. The examination will be conducted as per the University guidelines.
5. A candidate shall select only one elective from A to E in both the elective papers (BOT-602 and BOT-604) in Semester II. Other papers are common for all students in both the Semesters.
6. For Paper BOT-606, a student is required to prepare a dissertation carrying 100 marks. A student can start the project work in consultation with her/his supervisor from the beginning of the session. But the dissertation will be submitted at the end of the session. The dissertation will be examined by an examiner and the respective supervisor.
7. Grade Point Average (GPA) 5.5 shall be the minimum grade point to pass the M. Phil. Examination.
8. M.Phil. scholars shall present at least one (One) research paper in a Conference/Seminar before submission of dissertation and produce evidence for the same in the form of participation certificate and/or reprints.
9. In order to be eligible to appear at the University examination, a student has to secure at least 75% attendance.

**Programme Outcome:**

- The students will acquire basic knowledge on scientific communication, computer application, statistical methods, principles and application of scientific instruments, tissue culture techniques, methods of plant community study and environmental factors analysis. They can also able to learn the techniques of plant identification, herbarium preparation and application of various branches of biology to solve taxonomic problems.
- They will be equipped with adequate technical and analytical skill to pursue their future studies and to develop continuous learning throughout their professional career.
- They will be able to complete national and state level tests like UGC-CSIR (NET), ICAR (NET), UPSC, OPSC and SSB etc.
- They will acquire motivational forces for higher study and research related to applied field of plant sciences.

**Programme Specific Outcome:**

- Students will able to learn the basic principles and applications of scientific instruments in biological research for their higher education.
- They will able to involve in the environment programmes, launched by UNEP through inspirational and motivational ethics.
- They will understand the subject in detail through the elective courses such as Biosystematics, Environment Biology, Microbial Biotechnology, Physiology & Biochemistry and Plant Tissue Culture.
- They will acquire knowledge for reintroduction and conservation of rare, endemic and threatened (RET) taxa through plant tissue culture technique.
- They will motivate towards research in plant sciences through the dissertation work in both field and laboratory based exposure.

**DEPARTMENT OF BOTANY**  
**OUTLINE OF THE M.PHIL SYLLABUS**

**Semester-I**

<b>Course Code</b>	<b>Course Title</b>	<b>Marks</b>	<b>Credit</b>
BOT-601	Research Methodology (Theory)	50	5
BOT-603	Tools & Techniques (Theory)	50	5
BOT-605	Practical	100	10
Total		200	20

**Semester-II**

<b>Course Code</b>	<b>Course Title</b>	<b>Marks</b>	<b>Credit</b>
BOT-602	Elective (Theory) - I	50	5
BOT-602-A	A. Biosystematics		
BOT-602-B	B. Environmental Biology		
BOT-602-C	C. Microbial Biotechnology		
BOT-602-D	D. Physiology & Biochemistry of Stress		
BOT-602-E	E. Plant Tissue Culture		
BOT-604	Elective (Theory) - II	50	5
BOT-604-A	A. Biosystematics		
BOT-604-B	B. Environmental Biology		
BOT-604-C	C. Microbial Biotechnology		
BOT-604-D	D. Physiology & Biochemistry of Stress		
BOT-604-E	E. Plant Tissue Culture		
BOT-606	Dissertation	100	10
Total		200	20
<b>Grand Total</b>		<b>400</b>	<b>40</b>

## Semester-I

**Course Code Bot-601**

**Marks 50**

**Credit: 5**

**Course Title: Research Methodology (Theory)**

**Course objectives:** To acquire knowledge on research methodology basically on microscopy, the application of computer in biological research and data analysis. The students will be able to learn how to study scientific literature, research ethics, writing research proposal and Ph. D. thesis.

**Content:**

### **Unit-I**

The essential features of scientific communication, Ethics in communication, Introduction to scientific literature, Main types of scientific literature, Effective literature search. Reviewing Scientific literature, writing a literature review, writing a research proposal, writing a research paper, writing an abstract, preparing tables and figures, writing dissertation or Ph.D. thesis, Delivering effective oral presentation, preparing and presenting a research poster

### **Unit- II**

Basic computer organization, Storage devices, Computer software, Operating systems, MS Word, Menu, Use of key board shortcuts, Toolbar, Organizing files and folders, Creating a new document. Adjusting margins, paper size, Editing documents, Changing Font, Line spacing, Alignment, Using the ruler, Creating headers and footers, Inserting Page numbering, date time, symbol or character. Bullets and numbers, Putting a frame, Putting picture inside a report, Checking spelling, Grammar, Use of Thesaurus inserting a table, Entering and editing data, Print preview, Printing.

### **Unit-III**

Using Excel, Creating a new worksheet, Move, Copy, Insert, Delete worksheet, Excel formulas and functions, Rules for using formulas, Saving the workbook, Opening workbook, Naming cells and ranges, Auto fill, Auto complete, Auto correct, Adding and deleting cells, rows and columns, Preparation of Chart, Types of charts. Bar/Column, Pie/Doughnut/Radar, Line, Area/ Surface, XY (Scatter), Combination, Mapping a worksheet. Creating a map, Editing the map, Using Word with Excel and vice-versa.

### **Unit IV**

Using PowerPoint, How to start building a presentation, PowerPoint and its tools, Starting with or without a wizard, Templates, Opening an existing presentation, Starting from nothing, Adding special effects to the text, Inserting chart, pictures, Animation, Using Word and Excel with PowerPoint, Use of statistical packages for analysis of data

### **Unit V**

Measures of Dispersion: Standard deviation, Standard error, Test of significance, (Students T-test, F-test, ANOVA), Correlation Analysis and Regression Analysis.

**Course Outcome:** Upon successful completion of the course, students will be able to acquire knowledge on research methodology basically on microscopy, the application of computer in biological research and data analysis. The students will be able to learn how to study scientific literature, research ethics, writing research proposal and Ph. D. thesis. They can also know the better way of scientific communication.

Skill development in understanding a research problem, setting its hypothesis, carrying out research using different research methodologies and development of scientific journal, report review, project and thesis writing skills.

### **Recommended Books:**

1. Biostatistics: PN Arora & PK Malhan: Himalaya Publishing House

## Semester-I

**Course Code: Bot-603**

**Marks: 50**

**Credits: 5**

**Course Title: Tools & Techniques (Theory)**

**Course objective:** To know the methods and techniques of tissue culture along with the principles and applications of scientific instruments in biological research. Students can also able to know the methods of plant identification, preservation, plant community study including the water sample analysis.

**Content:**

### **Unit-I**

Culture methodology, Sterilization techniques, preparation of culture media, isolation and pure culture (Serial dilution, spread, pour and streak plate, crowded plate methods, enrichment culture methods, techniques for culture of autotrophic and anaerobic microbes), preservation techniques (on media, Sand, filter paper, mineral oil and cryopreservation methods)

### **Unit- II**

Tissue culture laboratory requirements and techniques: Media preparation room, Culture room, Culture vessels, Growth room, Green house, Aseptic manipulation: Sterilization of Glassware, Plastic-ware, Instruments, Media, Plant materials and Transfer area, Tissue culture media, Media constituents, Inorganic nutrients, Organic nutrients, Growth hormones, Gelling agents, Media selection and preparation.

### **Unit- III**

Spectrophotometry, Centrifugation, Chromatographic techniques, Thin layer chromatography, Column chromatography, Paper chromatography, Gas liquid chromatography, Ion exchange chromatography, affinity chromatography, TLC, HPLC, Polymer Chain Reaction (PCR), Tracer techniques and its application in biological research.

### **Unit-IV**

Electrophoresis of proteins and nucleic acids, Isolation and purification of genomic and plasmid DNA, Restriction digestion, Polymerase Chain Reaction, Southern blotting, Northern blotting, Western blotting.

### **Unit V**

Herbarium concept, function and management of herbarium, methods of plant identification, Keys for identification of angiospermic plants, Methods and techniques in plant community Studies, quadrat method, Species area curve, phytosociology, analysis of frequency, density, abundance, Importance Value index, Karyotypic analysis in relation to taxonomic problems, Palynological methods applied to taxonomy, Water analysis: pH, turbidity, dissolved oxygen, carbon dioxide and salinity, physicochemical characteristics of soil.

**Course Outcome:** By learning this course students will be able to know the methods and techniques of tissue culture along with the principles and applications of scientific instruments in biological research. Students can also able to know the methods of plant identification, preservation, plant community study including the water sample analysis.

Skill development and Employability Opportunities in Instrumentation and bio instrument marketing and sales

### **Recommended Books:**

- |   |                         |                                       |
|---|-------------------------|---------------------------------------|
| 1. Tools in Biochemistry                    | TG Cooper               | John Wiley                            |
| 2. Introductory Practical Biochemistry      | SK Sawhney & R. Singh   | Narosa Publication                    |
| 3. Experimental Biochemistry                | RL Dryer & GF Lata      | Oxford Univ. Press                    |
| 4. Handbook of Field Herbarium Methods      | SK Jain & RR Rao        | Today Tomorrow                        |
| 5. Plant Tissue Culture: Theory & Practice  | SS Bhojwani & MK Razdan | Elsevier Science Publishers, New York |
| 6. Plant Cell Culture: A Practical Approach | RA Dixon                | IRL Press, Oxford                     |

## Semester-I

**Course Code: Bot-605**  
**Course Title: Practical**

**Marks: 100**

**Credits: 10**

**Course Outcome:** Skill development in various tools and techniques related to plant science that will help t to undertake further Research. Employability scope in industries, research institutes and academics

- Isolation, enumeration and pure culture of microorganisms (Serial dilution, spread plate. Pour plate, Streak plate) from different samples.
- Study of different staining techniques for bacteria and fungi (Basic staining, Negative staining, Gram staining, Lactophenol cotton blue staining)
- Study of bacterial growth (Turbidometric and cell count method)
- Bacteriological examination of water and milk:
- Antibiotic sensitivity test
- Screening of microbes (bacteria and fungi) for different industrial enzymes.
- Plant tissue Culture techniques, Surface sterilization, Preparation of medium, Standardization of growth hormone concentration.
- Germination of seeds in aseptic condition, Inoculation and Sub-culture.
- Determination of total sugar content of supplied plant sample by Spectrophotometric method
- Estimation of protein content of supplied sample by Lowry method.
- Separation of proteins by gel electrophoresis.
- Separation of amino acids by Thin Layer Chromatography.
- Methods of field study and collection of specimens, herbarium preparation and submission pertinent to bio-systematic studies.
- Identification and formulation of diagnostic keys.
- Determination of floristic composition of a community.
- Determination of minimum size of the quadrat by Species-Area-Curve method.
- Determination of frequency, density, abundance of various species occurring in a given area.
- Determination of the IVI of various plant species.
- Determination of the biomass of various species in a given area.
- Determination of Dissolved Oxygen and free carbon dioxide of supplied water samples.
- Practical's pertaining to Paper Bot-601.

## Semester-II

**Course Code: Bot-602-A**  
**Course Title: Elective (Theory)-I**

**Marks: 50**  
**(A) Biosystematics- I**

**Credits: 5**

**Course Outcome:** To learn modern approaches of plant classification, basic principles of ICN, method of floristic study and conservation of plant genetic resources.

### **Content:**

#### **Unit-I:**

Synthetic Plant Classification: Characters of taxonomic significance morphological, anatomical, embryological, palynological, cytological and molecular phylogeny data for developing synthetic approach to plant classification.

#### **Unit- II:**

Plant Nomenclature: Development of ICN, Determination of types and typification, orthography of names and Epithets, Principles of priority and its limitation, Names of hybrids.

#### **Unit-III:**

Herbarium management: Concept, Historical development, Role of herbarium, changing nature of Herbarium, Preservation of specimens and Maintenance.

#### **Unit-IV:**

Floristic Survey: Field collection and preservation of specimens, Phytography, Assessment of threatened species, prioritization of RET taxa for conservation, Analysis of flora of Odisha, Documentation of data, Mangroves of Odisha- Significance and Conservation.

#### **Unit-V**

Taxonomy of cultivated plants: Centres of diversity and Centres of origin, Exploration and Selection of plant genetic resources, Establishment of gene banks, Cryopreservation.

**Course Outcome:** By opting the course, students will able to learn modern approaches of plant classification. They will also know the basic principles of ICN, methods of floristic study and conservation of plant genetic resources.

Skill development in various tools and techniques related to plant science that will help to undertake further Research. Employability scope in industries, research institutes and academics

### **Recommended Books:**

- |  |                              |                                |
|--|------------------------------|--------------------------------|
| 1. Plant Speciation                                | V Grant                      | Columbia University Press      |
| 2. New Concepts in Flowering Plant Taxonomy        | HJ Harrison                  | Hieman Educational Books, Lond |
| 3. Plant Taxonomy                                  | J Hesslop-Harrison           | ELBS & Edward Arnold, UK       |
| 4. Current Concepts in Plant Taxonomy              | VH Heywood & DM Moore        | Academic Press, London         |
| 5. Plant Systematics                               | SB Jones & AE Luchsinger     | McGraw Hill Book Company, NY   |
| 6. Plant Systematics for 21 <sup>st</sup> Century  | B Nordenstam, Gazaly, Kassar | Port Press Ltd., London        |
| 7. Fundamentals of Plant Systematics               | AE Radford                   | Harper & Row Publications      |
| 8. Plant Taxonomy & Systematics 2 <sup>nd</sup> Ed | CA Stace                     | Edward Arnold Ltd              |
| 9. Diversity & Classification of Fl Plants         | AC Takhtajan                 | Columbia Univ. Press, New York |



## Semester-II

**Course Code: Bot-602 B**  
**Course Title: Elective (Theory) - I**

**Marks: 50**  
**(B) Environmental Biology- I**

**Credits: 5**

**Course objectives:** To acquire knowledge on the concept and scope of environmental biology, environmental pollution and their management strategies.

### **Content:**

#### **Unit-I**

Definition, concept & scope of ecology and Environment: Atmosphere-Stratification. Hydrosphere-Distribution and Characteristics, Lithosphere- Physico- chemical characteristics, Soil formation and Development, Biosphere.

#### **Unit-II**

Concept of pollution, Sources of pollution, Types of pollutant and their nature, History of major pollution hazards, Nature of pollutant, Hazard potential and damages, Pollution monitoring and future management strategies. Role of state pollution control board and central pollution control board in pollution management.

#### **Unit-III**

Air pollution- Major & minor pollutants in atmosphere (Oxides of Sulphur, Nitrogen, Carbon, Hydrocarbons & Fluorides), their sources, atmospheric reactions and damages caused to ecosystem, Green house effect, Acid rain, Ozone depletion, Photochemical smog, Air pollution, prevention & control measures.

#### **Unit-IV**

Water pollution- Industrial wastes, Municipal wastes, Agricultural wastes, Eutrophication, Pollution due to heavy metals (Hg, Ar, Cr, Pb etc.), Ground water pollution, Prevention and control of water pollution.

#### **Unit-V**

Basic concepts of Toxicology, Toxic chemicals and their effect on Environment, effects of heavy metals on animal, Bioaccumulation and Biomagnification, Degradation of Toxic Chemicals- Xenobiotics, Sources and Types, Degradation of Xenobiotic compounds (Aliphatic, Alicyclic, Aromatic and Polycyclic hydrocarbons)

**Course Outcome:** By studying this course, the students can able to acquire knowledge on the concept and scope of environmental biology. They can also understand various types of environmental pollution and their management strategies.

Life skill development and Employment Opportunities in NGOs, Government Organizations, Forestry, Agriculture, Research Institutes, Industries

### **Recommended Books:**

1. Ecology and Field Biology: RL Smith: Harper Collins, New York
2. Ecology: M. Begon, J Harper & Townsend: Blackwell Scientific
3. Fundamentals of Ecology: EP Odum: Saunders
4. Basic Ecology: EP Odum: Saunders
5. Terrestrial Plant Ecology: MG Barnbaur, Bark, Bills: Benjamin/Cummings
6. Concepts of Ecology: EJ Kormondy: Prentice Hall
7. Ecology: Principles & Application: JL Chapman, MJ Reiss: Cambridge Univ.
8. Sustainability Indicators: B Moldan et al. John Willey
9. Understanding Environmental Pollution- MK Hill: Cambridge Univ. Press

## Semester-II

**Course Code: Bot-602-C**

**Marks: 50**

**Credits: 5**

**Course Title: Elective (Theory) - I**

**(C) Microbial Biotechnology- I**

**Course objectives:** To acquire knowledge on biotechnological application of microbial industry, role of microbes in recombinant DNA technology and Genetic engineering.

### **Content:**

#### **Unit-I**

Biotechnological application of microorganisms for industry: Characteristics of industrial microorganisms: Biosynthetic pathways of secondary metabolites in industrial microorganisms, genetics of microbes in relation to industrial requirements, pure culture methods and sources of industrial microbes, selection criteria of industrial microbes.

#### **Unit-II**

Fermentation media, sterilization, development of inocula, assay of fermentation products, types of fermentation, batch, continuous, feedback process, Bioreactors: Modes of operation, designing of bioreactors, downstream processing, product separation, concentration, purification and finishing of products.

#### **Unit-III**

Optimization of microbial products: Parameters for scale up, carbon substrate as energy source, macro and micronutrients, pH and temperature, control of toxic material, bio- availability of desired microbes, germplasm collection and maintenance.

#### **Unit-IV**

Industrial production of antibiotics, organic acids, amino acids, alcohol, vitamins, vaccines, enzymes, microbial production of Single Cell Protein (SCP).

#### **Unit-V**

Microbes in recombinant DNA technology and genetic engineering: Isolation and purification of DNA, restriction endonucleases, enzyme, digestion, electrophoretic separation of DNA fragments, SDS-PAGE for protein separation, northern, southern and western blotting, microbial bioinformatics.

**Course Outcome:** Students will acquire knowledge on biotechnological application of microorganisms for industry particularly the techniques of pure culture, fermentation, industrial production of secondary metabolites using the microbes. They can also know the role of microbes in recombinant DNA technology and Genetic engineering.

### **Recommended Books:**

1. Microbiology-An Introduction: GJ Tortora, BR Funckle & CL Case: The Benjamin/Cummings Publishing Company, Inc.
2. Microbiology: Klein, Harley & Prescott: John Willey
3. Microbiology: Principles & Experiments: JG Black: Benjamin/Cummings Publishing Company, Inc.
4. General Microbiology: Stanier: Blackwell Scientific Publication
5. Kuby Immunology: RA Goldsby, J Thomas: Freeman
6. Immunology: Roitt: John Willey

## Semester-II

**Course Code: Bot-602-D**  
**Course Title: Elective (Theory) - I**

**Marks: 50**  
**(D) Physiology & Biochemistry of Stress- I**

**Credits: 5**

**Course objective:** To know the plant physiology and adaptability against different biotic and abiotic stress.

### **Content:**

#### **Unit-I**

Plant stresses and their types: Response of plants to various stress conditions- stress injury, stress resistance and stress tolerance

#### **Unit-II**

Water Stress: Effects of water stress on plants (functioning of stomata, photosynthetic activity, osmotic adjustment, decrease in leaf area, root growth etc.), various adaptive responses of plants to water deficit and excess.

#### **Unit-III**

Salinity stress: Effects of salt stress (maintenance of water potential, stomatal movement, nitrogen metabolism, mineralization and ion imbalance etc.) and salt resistance strategies in plants.

#### **Unit-IV**

Temperature Stress: Stress due to high (Heat Stress) and low temperature (Chilling, Frost or freezing stress), Physiological and biochemical effects of temperature stress, High temperature induced protective proteins in plants. HSP accumulation and HSPs mediated tolerance to high temperatures, Adaptation of plant metabolism to temperature stress.

#### **Unit-V**

Light Stress: Light induced production of reactive oxygen species in plants and its damage to photosystem, Photo-protective strategies in plants.

**Course Outcome:** Upon successful completion of the course, students can understand the concept and types of plant stresses and mechanism of plant metabolism for their adaptation.

### **Recommended Books:**

1. Principles & Methods of Plant Molecular Biology, Biochemistry and Genetics P Devi Agrobios, Jodhpur
2. Stress: Physiology, Biochemistry, and Pathology: Handbook of Stress Series George Fink Academic Press
3. Stress Physiology D. P. Singh New age Int. Pub.

## Semester-II

**Course Code: Bot-602-E**

**Marks: 50**

**Credits: 5**

**Course Title: Elective (Theory) - I**

**(E) Plant Tissue culture-I**

**Course objectives:** To acquire knowledge on the techniques of tissue culture, techniques of somatic embryogenesis, haploid and triploid production including their applications and limitations.

### **Content:**

#### **Unit-I**

History of tissue culture, General techniques of micropropagation, Initiation of cultures. Multiplication, Callusing, Adventitious bud formation, Shoot regeneration, Rooting of shoots, Transplantation, Acclimatization, factors affecting *In vitro* stages of micropropagation, Application of micro-propagation, Limitations of micropropagation, Hyperhydration. Off- types, Contamination, Oxidative browning, Recalcitrance of adult trees, High costs.

#### **Unit-II**

Cell culture, Isolation of Single cells, Suspension cultures. Culture medium for suspensions, Agitation, Synchronization, Assessment of growth in suspension cultures, Assessment or viability of cultured cells, Culture of single cells, Factors affecting single cell culture, Plant cell reactors, Application of single cell culture.

#### **Unit III**

Somatic embryogenesis: Factors affecting somatic embryogenesis, Induction and development, Maturation of somatic embryos, Large scale production of somatic embryos, Synthetic seeds, Somaclonal variations, Origin of somaclonal variations, Mechanisms underlying somaclonal variations, Practical significance.

#### **Unit IV**

Haploid production: Anther culture, Isolated pollen culture, Factors affecting androgenesis, Ontogeny of androgenic haploids, Plant regeneration from pollen embryos, Gynogenesis, Haploid production through distant hybridization, Diploidization to produce homozygous diploid plants, Applications and limitations.

#### **Unit-V**

Triploid production: Endosperm culture, Histology and cytology of callus, Organogenesis, Applications of endosperm culture, *In vitro* pollination and fertilization: Zygotic embryo Culture.

**Course Outcome:** Students will able to acquire knowledge on the techniques of tissue culture and cell culture. They will also learn the methods and techniques of somatic embryos, haploid and triploid production including their applications and limitations.

Skill development in Plant Tissue Culture and Employability in Plant Tissue culture industries and Agrobusiness, Pharmaceutical industries, research institutes, academics and Entrepreneurship development

### **Recommended Books:**

- |   |                         |   |
|---|-------------------------|---|
| 1. Plant Tissue Culture: Theory & Practice          | SS Bhojwani & MK Razdan | Elsevier Science Publishers, New York   |
| 2. Plant Tissue Culture: Applications & Limitations | SS Bhojwani             | Elsevier Science Publishers, New York   |
| 3. Plant Cell & Tissue Culture                      | IK Vasil & TA Thorpe    | Kluwer Academic                         |
| 4. Plant Cell Culture: A Practical Approach         | RA Dixon                | IRL Press, Oxford                       |
| 5. Plant Cell Culture Protocols                     | RD Hall                 | Humana Press, USA                       |
| 6. Plant Biotechnology                              | J Hammond et al         | Springer-Verlag                         |
| 7. Biotechnology in Crop Improvement                | HS Chawla               | International Book Distributing Company |
| 8. Elements of Biotechnology                        | PK Gupta                | Rastogi and Co.                         |
| 9. Practical Application of Plant Molecular Biology | RJ Henry                | Chapman & Hall                          |

## Semester-II

**Course Code: Bot-604-A**

**Marks: 50**

**Credits: 5**

**Course Title: Elective (Theory) - II**

**(A) Biosystematics-II**

**Course objectives:** To learn the application of various branches of biology to solve the taxonomic problems, phytogeography and ecology of plants and use of computers in plant systematic study.

### **Content:**

#### **Unit-I**

Chemotaxonomy: Compounds useful in plant taxonomy, Primary and secondary metabolites. Semantides, Stages of chemotaxonomic investigation, Application of DNA Hybridization techniques in taxonomy.

#### **Unit-II**

Genetic techniques in Systematics, Genetic Analysis of characters and Phenetic variation, Dominance, Epistasis, Pleiotropy.

#### **Unit-III**

Phytogeography and Taxonomy: Taxonomic information from plant Geography and Ecology, Patterns of phytogeography, Disjunction, Vicariance, Endemism, Ecotypification, Alien species and its impact on native flora, Phenotypic plasticity.

#### **Unit-IV**

Molecular Taxonomy: Application of molecular markers, Isozyme. RAPD, AFLP, RFLP for phylogeny and establishment of genomic relationship, resolving taxonomic problems, Assessment of genetic diversity.

#### **Unit-V**

Taxonomic literature: Floras, Monographs and revisions, Use of computers in taxonomy, digitalization of herbarium, collecting and converting data, Documentation of characters.

**Course Outcome:** By studying this course, students will able to learn the application of various branches of biology to solve the taxonomic problems. They can also acquire knowledge on the phytogeography and ecology of plants. They can understand about the taxonomic literatures and use of computers in plant systematic study.

### **Recommended Books:**

- |  |                              |                                |
|--|------------------------------|--------------------------------|
| 1. Plant Speciation                                | V Grant                      | Columbia University Press      |
| 2. New Concepts in Flowering Plant Taxonomy        | HJ Harrison                  | Hieman Educational Books, Lond |
| 3. Plant Taxonomy                                  | J Hesslop-Harrison           | ELBS & Edward Arnold, UK       |
| 4. Current Concepts in Plant Taxonomy              | VH Heywood & DM Moore        | Academic Press, London         |
| 5. Plant Systematics                               | SB Jones & AE Luchsinger     | McGraw Hill Book Company, NY   |
| 6. Plant Systematics for 21 <sup>st</sup> Century  | B Nordenstam, Gazaly, Kassas | Port Press Ltd., London        |
| 7. Fundamentals of Plant Systematics               | AE Radford                   | Harper & Row Publications      |
| 8. Plant Taxonomy & Systematics 2 <sup>nd</sup> Ed | CA Stace                     | Edward Arnold Ltd              |
| 9. Diversity & Classification of Fl Plants         | AC Takhtajan                 | Columbia Univ. Press, New York |
| 10. Contemporary Plant Systematics                 | DW Woodland                  | Prentice Hall, New Jersey      |

## Semester-II

**Course Code: Bot-604-B**  
**Course Title: Elective (Theory) - II**

**Marks: 50**  
**Environmental Biology-II**

**Credits: 5**

**Course objective:** To know the principles and elements of environmental management, environmental impact assessment and management system and policies for conservation of natural resources.

### **Content:**

#### **Unit-I**

Environmental management- Principles and elements, Resource allocation, Responsibility and Accountability, Continuous performance evaluation, Top management committee and leadership. Environmental policy, Environmental targets including pollution prevention, British, ISO and Indian Standards.

#### **Unit-II**

Dimension of environmental degradation & concern of UNO on this matter, World Conference on Human Environment in Stockholm 1972, UNEP, Rio Conference 1992, Concept of sustainable development, Environmental impact assessment and management system.

#### **Unit-III**

Definition of Hazards and Disaster, Natural and Technological hazards, Hazards of materials, Toxic substances, High reactive substances and chemicals, Radio isotopes, Pathogens and Mutagens: Disaster Management-Management plans, guideline, methodology (Forecasting and warning systems, Emergency preparations, Pre and Post disaster phase).

#### **Unit-IV**

Causes and depletion of natural resources, Types of natural resources and their conservation. Mineral resources, Forest resources, Wildlife resources, Marine resources, Food and Agricultural resources, Energy resources, Energy plantations, Importance of fuel wood Plantation, Petro plants, Coal, Natural energy, Hydro electricity power and Thermal plant, Wind energy, Efforts on conservation of natural resources at National and International level.

#### **Unit-V**

Human rights and environment, World conservation strategy, World chapter for nature, World Commission on environment and development, Environmental policies-water Act, Air Act, EP Act 1986, Forest Act, Wild life Act. Manufacture, Storage and Hazardous chemical Rules. Insurance liability Act. Role of Pollution Control Board and its function.

**Course Outcome:** Upon successful completion of this course, students will able to know the principles and elements of environmental management. They can learn the environmental impact assessment and management system. Students will also know the environmental policies for conservation of natural resources.

### **Recommended Books:**

1. Ecology and Field Biology: RL Smith: Harper Collins, New York
2. Ecology: M. Begon, J Harper & Townsend: Blackwell Scientific
3. Fundamentals of Ecology: EP Odum: Saunders
4. Basic Ecology: EP Odum: Saunders
5. Terrestrial Plant Ecology: MG Barnbaur, Bark, Bills: Benjamin/Cummings
6. Concepts of Ecology: EJ Kormondy: Prentice Hall
7. Ecology: Principles & Application: JL Chapman, MJ Reiss: Cambridge Univ.
8. Sustainability Indicators: B Moldan et al. John Willey
9. Understanding Environmental Pollution- MK Hill: Cambridge Univ. Press

## Semester-II

**Course Code: Bot-604-C**  
**Course Title: Elective (Theory) - II**

**Marks: 50**  
**(C) Microbial Biotechnology-II**

**Credits: 5**

**Course Outcome:** To know the role of microbes in agriculture, food industry and waste water treatment.

### **Content:**

#### **Unit-I**

Role of microbes in agriculture, Symbiotic microorganisms and their applications, microbial inoculants, plant growth promoting rhizobacteria, phosphate and sulphate solubilising microorganisms, mycorrhiza, biological control of microbes, biopesticides and bioinsecticides.

#### **Unit-II**

Microbial spoilage of foods, indicator of food sanitary quality, food preservation methods, microbial production of food and food products, microbiology of milk and milk products.

#### **Unit- III**

Role of microbes in waste water treatment, microbial degradation of pollutants, xenobiotics, biosorption, microbial bioremediation, biotransformation, microbes in renewable energy production.

#### **Unit-IV**

Concept of pathogenicity, host-pathogen interaction, principles of plant infection, effects of parasites on host physiology, defense mechanisms in plants, role of phytoalexins in disease resistance, infectious diseases caused by bacteria (cholera, tuberculosis, anthrax), fungi superficial mycosis), viruses (hepatitis, AIDS), bioterrorism.

#### **Unit-V**

Overview of immune system, innate and adaptive immunity, antibody and its structure, monoclonal antibodies, antigens, antigen- antibody interactions, (agglutination, precipitation, Complement fixation), application of immunological techniques.

**Course Outcome:** Students will able to understand the role of microbes in agriculture, food industry and waste water treatment. They can also know the concept of pathogenicity and an overview of immune system.

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### **Recommended Books:**

1. Microbiology-An Introduction: GJ Tortora, BR Funck & CL Case: The Benjamin/Cummings Publishing Company, Inc.
2. Microbiology: Klein, Harley & Prescott: John Wiley
3. Microbiology: Principles & Experiments: JG Black: Benjamin/Cummings Publishing Company, Inc.
4. Microbiology: TD Brock: Benjamin/Cummings Publishing Company, Inc.
5. General Microbiology: Stanier: Blackwell Scientific Publication
6. Kuby Immunology: RA Goldsby, J Thomas: Freeman
7. Microbiological application-a lab manual-HJ Benson: WMC Book Publishers
8. Food Microbiology: MR Adams: Blackwell Scientific Publication

## Semester-II

**Course Code: Bot-604-D**  
**Course Title: Elective (Theory) - II**

**Marks: 50**  
**(D) Physiology and Biochemistry of Stress -II**

**Credits: 5**

**Course objectives:** To understand the mechanism of various types of stresses namely oxidative stress, pollution stress, and biotic stress and the mechanism of plant adaptability

**Content:**

### Unit-I

Oxygen deficiency and Oxidative Stress: Effect of oxygen deficiency in root and shoot growth, Synthesis of anaerobic stress proteins, Acclimation under hypoxia and anoxia, mechanism of oxygen activation during plant stress.

### Unit-II

Pollution Stress: Effect of different pollutants (e.g. Ultraviolet radiation. Hydrocarbons, SO<sub>2</sub>, CO<sub>2</sub>, and heavy metals) on growth and metabolism of plants, Various adaptive responses (resistance) of plants to pollution stress.

### Unit-III

Biotic Stress: Challenges of insects and pathogenic microorganisms and response of plants to insect damage and microbial pathogen infection.

### Unit-IV

Plant Acclimation to Environmental Stresses, Acclimation as a time-dependent phenomenon, Acclimation due to short-term responses (change in light, water availability and temperature etc.), Long-term acclimation, Role of oxygen during acclimation to various stresses.

### Unit-V

Plant adaptations to Environment and Plant Biomes, Sun and Shade adapted plants, Adaptation of C<sub>4</sub> plants to High temperature and Drought, CAM metabolism an adaptation to Desert life, Regulation of C<sub>4</sub> and CAM photosynthesis: Physiological adaptations and plant Biomes.

**Course Outcome:** By opting this course, students will able to understand the mechanism of various types of stresses namely oxidative stress, pollution stress, and biotic stress. Most importantly they can also able to know the mechanism of plant adaptation to environment during the environmental stress.

### Recommended Books:

1. Principles & Methods of Plant Molecular Biology, Biochemistry and Genetics P Devi Agrobios, Jodhpur
4. Stress: Physiology, Biochemistry, and Pathology: Handbook of Stress Series George Fink Academic Press
5. Stress Physiology D. P. Singh New age Int. Pub.



## Semester-II

**Course Code: Bot-604-E**

**Marks: 50**

**Credits: 5**

**Course Title: Elective (Theory) - II**

**(E) Plant Tissue culture-II**

**Course objective:** To learn the techniques of protoplast isolation and genetic transformation and transgenic plants for crop improvement.

### **Content:**

#### **Unit-I**

Protoplast isolation and culture: Isolation of protoplasts. Factors affecting yield and viability of protoplasts, Protoplast culture, Protoplast fusion, Selection of fusion product, Verification of hybridity, Genetic consequences of protoplast fusion, Symmetric hybridization, Asymmetric hybridization, Cybridization.

#### **Unit- II**

Genetic Transformation: Gene transfer to plants, *Agrobacterium* mediated genetic transformation of plants: T-DNA organization and transfer, Ti plasmid, Ti plasmid-derived vector system. Co-integrate vectors. Binary vector, Method for *Agrobacterium*- mediated transformation, *Agrobacterium rhizogenes* - mediated transformation.

#### **Unit-III**

Methods for direct DNA delivery, Chemical transformation, Electroporation, Microinjection Particle bombardment method, Selection of transformed plants, Commonly used Selectable markers and reporter genes, Molecular analysis of transformed plants to detect foreign gene and gene products, Chloroplast transformation, Transgene silencing.

#### **Unit-IV**

Transgenic plants for crop improvement: Virus resistance, Expression of virus coat protein, Expression of satellite RNAs, Use of antisense viral RNA: Resistance to Fungi and Bacteria. Insect resistance, Bt toxin gene expression, Trypsin inhibitor gene expression, Herbicide tolerance, Nuclear male sterile lines for hybrid seed production, Development of Oxidative stress, Salt stress- tolerant plants, Control of senescence and fruit ripening, Genetic manipulation of flower pigmentation, Modification of plant nutritional content, Modification of food plant appearance and taste, Plants as bioreactors, Bio-safety of transgenic plants.

#### **Unit-V**

*In vitro* pollination and fertilization: Ovule culture, Ovary culture, Applications, Production of pathogen free plants, Virus elimination by heat treatment, Meristem tip culture and *In vitro* Shoot tip grafting, Production or secondary metabolites, Germplasm storage.

**Course Outcome:** By studying this course, students will able to learn the techniques of protoplast isolation and genetic transformation. They can also learn the role of transgenic plants for crop improvement.

### **Recommended Books:**

- |   |                         |   |
|---|-------------------------|---|
| 1. Plant Tissue Culture: Theory & Practice          | SS Bhojwani & MK Razdan | Elsevier Science Publishers, New York   |
| 2. Plant Tissue Culture: Applications & Limitations | SS Bhojwani             | Elsevier Science Publishers, New York   |
| 3. Plant Cell & Tissue Culture                      | IK Vasil & TA Thorpe    | Kluwer Academic                         |
| 4. Plant Cell Culture: A Practical Approach         | RA Dixon                | IRL Press, Oxford                       |
| 5. Plant Cell Culture Protocols                     | RD Hall                 | Humana Press, USA                       |
| 6. Plant Biotechnology                              | J Hammond et al         | Springer-Verlag                         |
| 7. Biotechnology in Crop Improvement                | HS Chawla               | International Book Distributing Company |

## **Semester-II**

**Course Code: Bot-606**  
**Course Title: Dissertation**

**Marks: 100**

**Credits: 10**

Each student is required to carry out a project work relating to his/her experimental research work under the supervision of a faculty member and submit a report in the form of a dissertation before the commencement of theory examination.

Skill development with long term hands - on -training on various biotechniques, microbial and plant tissue techniques, biotechnological tools, genetic engineering techniques, tools used for environmental and industrial biotechnology along with data analysis software training for application of the research theme chosen for the Dissertation and further research and employability scope in Industries, Institutes and Academics