

COURSES OF STUDIES

FOR

M.Sc. EXAMINATION

(With effect from 2021-2022)

BOTANY

(Semester System)



MAHARAJA SRIRAM CHANDRA BHANJA DEO UNIVERSITY
SRIRAM CHANDRA VIHAR
TAKATPUR, BARIPADA-757003

M.Sc. (BOTANY) EXAMINATION

SEMESTER SYSTEM

(Choice Based Credit System)

1. The course is of two years duration comprising of four semesters of theory and laboratory works.
2. There is one open elective (OE-BOT- 412) in semester-II. This paper is open for other departments. Students of this department in semester –II will choose one open elective from other department.
3. Each student has to carry out project work from Semester-III and submit a dissertation before the commencement of Semester-IV theory examination.
4. The student can opt one elective course comprising of two papers in the 2nd year of PG programme.
5. The theory examination shall be held for 80 marks (3 hours) and one Internal Assessment Examinations (IAE) of 20 marks (1 hour). The questions shall be of unit pattern, having equal marks, with two alternatives from each unit.
6. For IAE, question shall be asked at least from any two units of a paper covered and will be of one hour duration. The durations of the practical examination shall be 6 hours.
7. For passing semester examinations a candidate must secure a minimum of 40% marks in practical and 30% marks in theory papers.
8. A student securing cumulative Grade Point Average (CGPA) 5.5 shall be declared as pass the Post-Graduation Examination.
9. A candidate securing at least 6.75 CGPA (minimum 60% marks in aggregate) shall be declared as First Class. The First Class First student shall receive the University Gold Medal in the concerned regular P.G. Course provided that he/she has cleared all the papers of the semester examinations in one chance.
10. If candidate passes all the four semester examinations he/she will be declared to have passed the M.Sc. (Semester) examinations in Botany, provided further that in no case a candidate shall be allowed to appear any Semester Examination after twice the duration of course period.
11. In order to be eligible to appear at the University examination, a student has to secure at least 75% of attendance.

Programme outcome:

- The students will acquire basic knowledge on plant diversity, conservation and utilization of phyto-resources and role of plant community in protection of environment.
- They will be able to contribute towards present day struggle for climate change, global warming, restoration and reclamation of waste land for crop production and inventorisation of plants for new phytochemicals & drugs.
- They will be equipped with adequate technical and analytical skill to pursue their further studies and to develop continuous learning throughout their professional career.
- They will be able to compete 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:

- The student will understand both the basic and applied branches of plant sciences namely Biosystematics, Environmental Sciences, Plant Biotechnology, Plant Physiology & Biochemistry and Industrial Microbiology.
- Systematic study of selected taxa will explore the knowledge on the taxa including genetic diversity and molecular phylogeny which will be helpful for conservation & sustainable utilization of those taxa.
- They will develop creative thinking and problem solving capabilities through mentor system.
- They will be 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 Pollution and Management, 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.

(Effective from the academic session 2021-22)

Semester –I

Code	Course Title	Credit	Marks
BOT 401	Plant Diversity-I (Microbes & Algae)	5	100 (80+20)
BOT 403	Genetics & Biostatistics	5	100 (80+20)
BOT 405	Plant Metabolism-I	5	100 (80+20)
BOT 407	Angiosperm Taxonomy & Plant Resource Utilization	5	100 (80+20)
BOT 409	Practical pertaining to papers 401, 403, 405 & 407	5	100
	Total	25	500

Semester –II

Code	Course Title	Credit	Marks
BOT 402	Biodiversity Conservation	5	100 (80+20)
BOT 404	Plant Diversity-II (Fungi & Bryophyta)	5	100 (80+20)
BOT 406	Cell and Molecular Biology	5	100 (80+20)
BOT 408	Ecology & Developmental Biology	5	100 (80+20)
BOT 410	Practical pertaining to papers 404, 406 & 408	5	100
BOT-412 (OE)	Biodiversity Assessment and Conservation	5	100 (80+20)
	Total	30	600

Semester –III

Code	Course Title	Credit	Marks
BOT 501	Environmental Biotechnology & Management	5	100 (80+20)
BOT 503	Plant Diversity-III (Pteridophyta & Gymnosperms)	5	100 (80+20)
BOT 505	Plant Metabolism-II	5	100 (80+20)
BOT 507	Elective	5	100 (80+20)
BOT 509	Practical pertaining to papers 503, 505 & 507	5	100
	Total	25	500

Semester –IV

Code	Course Title	Credit	Marks
BOT 502	Plant Biotechnology & Genetic Engineering	5	100 (80+20)
BOT 504	Elective	5	100 (80+20)
BOT 506	Practical pertaining to theory paper 504	5	100
BOT 508	Project, Seminar presentation and Viva voce	5	100
	Total	20	400

Grand Total of Four Semesters **100** **2000**

Number of contact periods per week: 4.5 hours per 5 credit theory paper; 6 hours per 5 credit practical paper. Elective = The student has to opt for any one of four Electives Biochemistry/ Biosystematics/ Environmental Pollution & Management/ Industrial Microbiology). Each student has to carry out project work from Semester-III and submit a dissertation before the commencement of Semester-IV theory examination. The dissertation will be evaluated in Semester-IV. **OE:** Open Elective allotted to other Department students.

SEMESTER-I

BOT-401 Plant Diversity-I (Microbes & Algae)

Full Mark: 80

Course objective: To acquaint the knowledge on microbes and algae with respect to human welfare.

Content:

UNIT -I

(20)

History and scope of microbiology, functional anatomy of prokaryotic and eukaryotic cells, general account of archaeobacteria, mycoplasma, eubacteria, sterilization techniques, culture media for microorganisms, culture techniques, staining techniques, microbial growth, measurement of microbial growth and control of microbial growth.

UNIT -II

(20)

General properties of viruses, structure and classification of viruses, viral multiplication, the lytic cycle, the lysogenic cycle, symptoms of plant virus infection, transmission of plant viruses, effects of virus infection on host plants' metabolism.

UNIT- III.

(20)

General properties of bacteria, structure, bacterial replication, bacterial genetics, plasmids and episomes, industrial uses of bacteria, role of bacteria in industrial and domestic sewage, microbial fermentation.

UNIT- IV

(20)

General characteristics of algae, Pigmentation in algae, Modern system of classification, Reproduction in algae (vegetative, asexual and sexual), Life cycles in algae, Beneficial and harmful aspects of algae, Salient features of Cyanophyta, Prochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

Course Outcome: Upon successful completion of this course student will be able to acquire basic knowledge on microbial diversity, various techniques of microbial culture, control and measurement of microbial growth. A detailed knowledge can be obtained on bacteria, viruses and their characteristics, reproduction and application for human benefits.

Recommended Books:

1. Microbiology-An Introduction: GJ Tortora, BR Funck & 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. Microbiology: TD Brock: Benjamin/Cummings Publishing Company, Inc.
5. General Microbiology: Stanier: Blackwell Scientific Publication
6. Basics of Plant Virology: HN Verma: Oxford IBH Publishing Company
7. Introductory Phycology: HD Kumar: Affiliated East-West Press, New Delhi
8. An Introduction to the Algae: I. Morris: Cambridge University Press
9. The Biology of Algae: FE Round: Cambridge University Press

SEMESTER-I

BOT-403

Genetics & Biostatistics

Full Mark: 80

Course objective: Student will acquire basic knowledge on principles of genetics, molecular biology and Biometry.

Content:

UNIT- I

(20)

Mendelian principles, Deviation from Mendelian inheritance, Maternal inheritance, Polygenic inheritance, Structural alteration of chromosomes or chromosomal aberration, Deletion or Deficiency, Duplication, Translocation, Inversion, Variation in chromosome number or polyploidy.

UNIT- II

(20)

Gene transfer in bacteria- Transformation, Sexual conjugation and Transduction (generalized and specialized transduction), Sex-duction, Mapping of bacterial genome, Transformation mapping, Conjugation mapping, Transduction mapping.

UNIT- III

(20)

Mutation, Types, Causes, Detection, DNA damage and repair; Linkage and recombination, Linkage groups, Complete linkage, Incomplete linkage and recombination, Four strand crossing over, Detection of linkage, Gene mapping in diploids, Double crossing over, Coincidence and Interference, Linkage maps.

UNIT -IV

(20)

Population and sample, Measures of central tendency, Mean, Median, Mode, Measures of dispersion, Range, Mean deviation, Standard deviation and Standard error, Tests of Significance, t-test, F-test and χ^2 test.

Course Outcome: Students will able know about Mendelian Principle, Inheritance Deviation and genetic variability. Skill development in Genetic Analysis Skills and on Data Analysis Software Usage for different problems pertaining to data analysis and validation. Employment Opportunities in Agro-industries, research institutes and extending consultation service

Recommended Books:

1. The Science of Genetics: Atherly, Girton, Mc Donald: Saunders College Publication
2. Genetics: PJ Russel: The Benjamin/ Cummings Publisher
3. Principles of Genetics: DP Snustad & MJ Simmers: John Willey
4. Genetics: MW Strickberger: Mc Millan
5. Genetics: PK Gupta: Rastogi Publication
6. Cytogenetics: PK Gupta: Rastogi Publication
7. Principles & Practice of Plant Breeding: JR Sharma: Tata McGraw Hill
8. Principles of Crop Improvement: NW Simmonds: Longman, London
9. Cytology & Genetics: S Sen & DK Kar: Narosa Publishing House
10. Hybrid Cultivar Development: SS Banga & SK Banga: Narosa Publishing House
11. Breeding Field Crops: JM Poehlman & DR Sleeper: Panima Publishing
12. Microbial Genetics: D. Freifelder: Narosa Publishing House
13. Principles & Procedures of Plant Breeding: GS Chahal & SS Ghosal: Narosa Publishing House
14. Biostatistics: PN Arora & PK Malhan: Himalaya Publishing House

SEMESTER-I

BOT-405

Plant Metabolism-I

Full Mark: 80

Course objectives: To acquaint with various metabolic pathways, nature and mode of action of enzymes and nitrogen fixation of plant. To achieve knowledge on principle and application of various instruments used in biological research.

Content:

UNIT- I.

(20)

Definition of metabolism, metabolic pathways, Anabolic and catabolic pathways, Central pathways, Anaplerotic pathways, Regulation of metabolic pathways.

UNIT -II.

(20)

General aspects, Distribution, Nomenclature and Classification of enzymes, Nature and Mode of action of enzymes, Enzyme kinetics, Michaelis Menton equations, Isoenzymes.

UNIT -III

(20)

Ammonification and Nitrification, Nitrate assimilation, Nitrogen fixation (Non-biological and Biological nitrogen fixation.

UNIT -IV

(20)

Principles and application of Spectrophotometry, Ultra-centrifugation, Chromatography, Ion exchange and affinity chromatography, Thin layer and Gas chromatography, Electrophoresis.

Course Outcome: Student will be able to understand the mechanism of plant metabolism, enzyme kinetics and nitrogen fixation. They will also acquire knowledge on principles and applications of various instruments in biology which help them for their employability in future.

Recommended Books:

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|---|-----------------------|--|
| 1. Plant Physiology | FB Salisbury & CW Ros | Wadsworth Publishing |
| 2. Introductory Practical Biochemistry | SK Sawhney & R. Singh | Narosa Publication |
| 3. Biochemistry & Molecular Biology of Plants | Buchanan et al | American Society for Plant Physiologists |
| 4. Plant Metabolism | DT Dennis et al | Longman |
| 5. Biochemistry & Molecular Biology of Plant Hormones | PJJ Hooykaas et al | Elsevier, Amsterdam |
| 6. Biochemistry & Physiology of Plant Hormones | TC Moore | Springer-Verlag |
| 7. Physiochemical & Environmental Plant Physiology | PS Nobel | Academic Press |
| 8. Plant Physiology | Taiz & Zeiger | Sinaur Associates |
| 9. Tools in Biochemistry | TG Cooper | John Wiley |
| 10. Biochemistry | Lehninger, A | International Book Distribution |

SEMESTER-I

BOT-407 Angiosperm Taxonomy and Plant Resource Utilization Full Mark: 80

Course objectives: To acquire knowledge on plants taxonomy, herbarium methodology economic importance of cultivated plants.

Content:

UNIT- I

(20)

Principles of Plant Nomenclature, Salient features of International Code of Nomenclature for algae, fungi and plants, Typification, Rules of priority, Ranks of taxa, Citation of author, Effective and valid publication, Hierarchy and taxonomic categories, Concept of species.

UNIT -II

(20)

Types of classification of flowering plants: Natural and phylogenic systems. Bentham and Hooker, Hutchinson, Cronquist, Takhtajan, and Angiosperm Phylogeny Group (APG) System of classification, Taxonomic tools, Herbarium methodology, Collection, Identification, Preservation, Role of botanic gardens in taxonomy.

UNIT -III

(20)

Range of floral structure in Rosales, Rubiales, Asterales, Glumiflorae and Scitaminae.

UNIT -IV

(20)

Origin, Botany, Cultivation and utilization of rice, jute and groundnut; Uses of medicinal and aromatic plants, Cash crops, Beverages, Species & Condiments, timber yielding plants, Non-timber forest products (Bamboos, Rattans, Cordages, Fibres, Resins, Gums, Dyes, Tannins).

Course Outcome: Students will know the general principles of ICN, classification of flowering plants and techniques of plant collection identification and preservation. They will be able to understand the plants with reference to their origin, uses and cultivation.

Employability in Agriculture, Forestry, Entrepreneurship development and extending Consultancy services

Recommended Books:

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| 1. Taxonomy of Angiosperms | VN Naik | Tata McGrawHill |
| 2. Flora of Orissa (Four Volumes) | Saxena & Brahmam | OFDC, Bhubaneswar |
| 3. The Botany of Bihar & Orissa (3 Vols) | HH Haines | Bishen Singh & Mahinder Palsing |
| 4. Handbook of Palynology | G Erdtman | Hafner, New York |
| 5. An Aid to ICBN | Henry & Chandra Bose | Today & Tomorrow Publication |
| 6. A Textbook of Economic Botany | A Sambamurthy and Subramaniam | Willey Eastern |
| 7. Economic Botany in the Tropics | SL Kochar | Mac Millan |
| 8. Principles of Angiosperm Taxonomy | PH Davis & VH Heywood | Robert E Kreiger Publishing Co |
| 9. Current Concepts in Plant Taxonomy | VH Heywood & DM Moore | Academic Press, London |
| 10. Plant Systematics | SB Jones & AE Luchsinger | McGraw Hill Book Company, NY |

BOT- 409 Practical pertaining to theory papers 401, 403, 405 & 407

Full Mark: 100

1. Learning about laboratory safety rules and basic requirements.
2. Methods of sterilization and preparation of culture media.
3. Study of pure cultures (Serial dilution, Spread plate, Pour plate, Streak plate).
4. Staining techniques for microorganisms (Basic staining, Negative staining, Gram staining, Acid fast staining, Lactophenol cotton blue staining).
5. Study of microbial growth.
6. Identification of algal samples through temporary mounting.
7. Separation and identification of algae from mixed population.
8. Calculation of mean, median and mode.
9. Computation of standard deviation & Standard error.
10. Application of Chi-square test.
11. Determination of absorption maxima of Methyl orange/ Bromophenol blue and verification of Beer-Lambert's Law.
12. Separation of plant pigments/ amino acids by Paper Chromatography.
13. Demonstration of Thin Layer Chromatography (TLC).
14. Demonstration of Polyacrylamide gel electrophoresis.
15. Field visit to acquaint the students with local flora and Protected Area Network.
16. Determination of distribution and population status of taxa occurring in local flora.
17. Identification of species and assignment of correct names of selected taxa. Herbarium methodology: collection, preservation, mounting and submission of herbarium.
18. Economic valuation of biodiversity using Belal & Springuel method.
19. Collection and study of plants of ethno-botanical and other economic importance.
20. Study of biotic and abiotic pressure and determination of extinction threats.

Semester-II

BOT- 402

Biodiversity Conservation

Full Mark: 80

Course objectives: To know the concept and importance of biodiversity and its conservation for human welfare.

Content:

Unit -I

(20)

Fundamentals concept of Biodiversity (Species diversity, Genetic diversity and Ecosystem diversity); Importance of Biodiversity (Direct Values, Ecosystem services and cultural values); Biodiversity of sustainable production and development.

Unit -II

(20)

Microbial diversity: Diversity of microbial world (Algal, Fungal, Bacterial) at National and global level; Microorganisms and the balance of nature; Value of microbial biodiversity, Bioremediation, Biopesticide, Biofertilizers.

Unit -III

(20)

Biodiversity assessment and status, Concept and application of diversity indices for biodiversity monitoring (Shannon diversity index, Simpson's Index, Species richness and evenness index), Prioritization of taxa for conservation of rare, endemic, threatened (RET) taxa.

Unit -IV

(20)

Conservation of biodiversity, Threats to loss of biodiversity, Endemism, phytogeography and its significance, phytogeographical zones of India, *in situ* & *ex situ* conservation, Gene bank, Biodiversity conservation policy decision in India; Indian Biological Diversity Act and Intellectual Property Rights (IPR).

Course Outcome: Students will be able to understand the fundamental concept and importance of biodiversity. Most importantly, the students will learn the techniques to assess biodiversity and prioritization of taxa for conservation.

Employability in Agriculture, Forestry, NGOs and Government Organization and scope for extending Consultation Services

Recommended Books:

1. Text book of Biodiversity: K V Krishnamurthy: CRC Press
2. Measuring Biological diversity: A.E. Magurran: Blackwell publishing
3. Biodiversity: An introduction: Second Edition: Kevin J Gaston and John I. Spicer: Blackwell publishing
4. Ecology: Ricklefs and Miller: Fourth Edition: W. H. Freeman
5. Ecology: Theories and Applications: Peter Stiling
6. Ecology: From Individuals to Ecosystems: Begon, Townsend and Harper
7. Ecology: E.O. Wilson

Semester-II

BOT- 404 Plant Diversity –II (Fungi, Lichens & Bryophytes) Full Mark: 80

Course objective: To acquire the basic knowledge on classification, reproduction and economical importance of Fungi, Lichens and Bryophytes.

Content:

UNIT- I (20)

General characters of fungi, fungi in diversified habitats, origin and classification in fungi, unicellular and multicellular organization, cell wall composition, nutrition in fungi (saprobic, biotrophic, symbiotic), reproduction (vegetative, asexual, sexual), heterothallism, heterokaryosis, parasexuality, trends in sporangial evolution, discharge and dissemination of spores, degeneration of sex in fungi.

UNIT -II (20)

General accounts of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina. General characters, origin and classification of lichens, external and internal thallus organization, reproduction of lichen, economic and industrial uses of lichens, single cell proteins, mushroom culture.

UNIT -III (20)

General characters of Bryophytes, evolutionary trends among bryophytes, morphology, distribution, internal structure, reproduction and life cycle of bryophytes, economic importance of bryophytes, ecological significance of bryophytes.

UNIT -IV (20)

General accounts of Marchantiales, Jungermanniales, Anthocerotales (Anthoceros), Sphagnales, Funariales (Funaria) and Polytrichales; Evolution of sporophytes in bryophytes; Progressive sterilization of sporogenous tissue in bryophytes; Spore dispersal mechanisms in Bryophytes.

Course Outcome: Upon completion, students will be able to know the general characteristics, classification, reproduction and economic importance of fungi, lichen and bryophytes.

Recommended Books:

1. Introductory Mycology: CJ Alexopoulos & C.W. Mims: John Wiley
2. An Introduction to Mycology: RS Mehrotra & RS Aneja: New Age Intermediate Press
3. Introduction to Fungi: J Webster: Cambridge University Press
4. Fungi: BR Vashista & AK Sinha: S. Chand & Company
5. Bryophytes: Prem Puri: Atma Ram & Sons
6. Bryophyta: NS Parihar: Central Book Depot, Allahabad

Semester-II

BOT- 406

Cell & Molecular Biology

Full Mark: 80

Course objective: To be familiar with the basic knowledge on molecular biology.

Content:

UNIT- I (20)

Structural organization and function of intra-cellular organization, Cell wall, Plasma membrane, Nucleus, Mitochondria, Chloroplast, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisome, Vacuoles, Structure and function of cytoskeleton.

UNIT- II (20)

Structure of chromosomes, Nucleosome, Heterochromatin and Euchromatin, Special types of chromosomes, Cell division and cell cycle, Mitosis and Meiosis, Control of Cell cycle.

UNIT- III (20)

Nucleic acids as the genetic material, Structure of DNA, Types of RNA, DNA replication, Nearest neighbor analysis, Fidelity of DNA replication, RNA structure and forms, Transcription, Capping & Poly-adenylation, DNA sequencing (Maxam & Gilbert's method, Sanger's method).

UNIT- IV (20)

Protein synthesis, components of protein synthetic machinery, initiation of protein synthesis, formation of initiation complex, initiation factors, elongation factors, termination and release of polypeptide chain, post-translational modification of proteins.

Course Outcome: Students will acquire basic knowledge on structure & function of cell & molecular biology, nucleic acid, cell division, cell cycle and the mechanism of protein synthesis.

Skill development and Employment Opportunities in Biomedical and Pharmaceutical and Allied Industries

Recommended Books:

1. Genes VIII: Benjamin Lewin: Oxford IBH
2. Cell & Molecular Biology: Concepts & Experiments: G. Karp: John Willey
3. Molecular Biology of the Cell: Alberts, Bray, Lewis et al: Garland Publisher
4. Essentials of Molecular Biology: MD Freifelder: Jones & Barlet Publisher
5. Molecular & Cellular Biology: SL Wolfe: Wadsworth Publishing
6. Molecular Cell Biology: H Lodish et al: WH Freeman, New York
7. Cell & Molecular Biology: De Robertis & Robertis: Blackwell
8. Cell Biology-Fundamentals: PK Gupta: Rastogi Publication

Semester-II

BOT- 408

Ecology & Developmental Biology

Full Mark: 80

Course objective: To Know about the principles of ecology, ecosystem, nutrient cycle and tissue system in plants.

Content:

UNIT- I

(20)

Principles of ecology and its divisions, application of plant ecology, ecosystem, structure of ecosystem, function of ecosystem, types of ecosystems, processes within the ecosystems, energy and its flow in ecosystem, Biogeochemical cycles, characteristics of population: density, natality, mortality, population growth, age-distribution of population, population fluctuations, population structure, interaction among populations.

UNIT- II

(20)

Community concept, community development and organization, floristic composition, stratification, phenology, vitality or vigor of the individual, sociability or gregariousness and interdependence, life form and physiognomy, trophic organization, distribution pattern, frequency, density, abundance, IVI, presence and Constance, fidelity, dominance, indices of diversity and dominance, Evenness index, Equitability index.

UNIT- III

(20)

Tissue system in plants, meristematic tissue system, primary and secondary tissue systems, organization of shoot and root apical meristem, formation of lateral organs, leaf development, dermal tissue system, mechanical tissue system, secondary growth and anomalous secondary growth.

UNIT- IV

(20)

Microsporogenesis, development of male and female gametophyte, pollination and fertilization, endosperm, polyembryony, apomixes, sexual incompatibility.

Course Outcome: Students will be able to understand the principles of ecology, components of ecosystem and cycling of nutrients. They will be able to learn the methods of assessing vegetation quantitatively and also acquire knowledge on developmental biology which help them to conserve the ecosystem in general and environment in particular.

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. Concepts of Ecology: EJ Kormondy: Prentice Hall
5. Ecology: Principles & Application: JL Chapman, MJ Reiss: Cambridge Univ.
6. A Text Book of Plant Ecology: Ambasht&Ambasht: Vikash Publishing
7. Modern Concept of Ecology: HD Kumar: Vikash Publishing
8. General Ecology: HD Kumar: Vikash Publishing
9. The Embryology of Angiosperms: SS Bhojwani, SP Bhatnagar: Vikash Publishing
10. An Introduction to Plant Cell Development: J Burgess: Cambridge Univ. Press

BOT-410 Practical pertaining to theory papers 404, 406 & 408

Full Mark: 100

1. Local field trip to acquaint the students with occurrence of Fungi, Lichen and Bryophytes.
2. Preparation of temporary and permanent slides and study of vegetative and reproductive structures of members of fungi.
3. Preparation of temporary and permanent slides lichen.
4. Study of morphological and anatomical features (vegetative and reproductive) of different classes of Bryophytes. Preparation of permanent slides and study of vegetative and reproductive structures of members of Bryophytes. The students have to submit permanent slides.
5. Demonstration on pretreatment, fixation, staining and squashing technique for cytological analysis.
6. Study of different stages of Mitosis and Meiosis of *Allium cepa*..
7. Study of Karyotype and abnormal chromosomal features.
8. Extraction of protein from tissue homogenate and analysis by SDS-PAGE.
9. Preparation of permanent slides and study of anatomical features of stem and root of selected angiospermic plants.
10. Preparation of micro slides and study of anomalous secondary growth in selected angiospermic plants.
11. Study of anatomical and physiological adaptations in hydrophytes, xerophytes and epiphytes.
12. Microscopic preparation and study of embryological slides.
13. Determination of minimum size of the quadrat by Species Area Curve method
14. Determination of Frequency, Density and Abundance of different species in a grassland community

Semester - II

OE-BOT- 412 Biodiversity Assessment and Conservation Full Mark: 80

Course objective: To discern about fundamental concept, assessment and conservation of biodiversity

Content:

Unit -I

(20)

Fundamentals concept of Biodiversity (Species diversity, Genetic diversity and Ecosystem diversity); Importance of Biodiversity (Direct Values, Ecosystem services and cultural values); Biodiversity of sustainable production and development.

Unit –II

(20)

Biodiversity assessment and status: Concept and application of diversity indices for biodiversity monitoring (Shannon diversity index, Simpson's Index, Species richness and evenness index), Prioritization of taxa for conservation of rare, endemic, threatened (RET) taxa.

Unit –III

(20)

Endemism, Biodiversity hotspots, phytogeography and its significance, phytogeographical zones of India, Biodiversity conservation policy decision in India; Indian Biological Diversity Act and Intellectual Property Rights (IPR).

Unit –IV

(20)

Threats to loss of biodiversity, Conservation of biodiversity:*in situ* (Wildlife Sanctuaries, National Parks, Biosphere Reserve and Sacred groves)&*ex situ* conservation (Botanic Garden, Gene bank, Seed bank, Cryopreservation, Tissue culture technique, Micropropagation).

Course Outcome: Students will be able to understand the fundamental concept and importance of biodiversity. Most importantly, the students will learn the techniques to assess biodiversity and prioritization of taxa for conservation. Further, they will also learn the modern techniques of biodiversity conservation.

Recommended Books:

1. Text book of Biodiversity: K V Krishnamurthy: CRC Press
2. Measuring Biological diversity: A.E. Magurran: Blackwell publishing
3. Biodiversity: An introduction: Second Edition: Kevin J Gaston and John I. Spicer: Blackwell publishing
4. Ecology: Ricklefs and Miller:Fourth Edition: W. H. Freeman
5. Ecology: Theories and Applications: Peter Stiling
6. Ecology: From Individuals to Ecosystems: Begon, Townsend and Harper
7. Ecology: E.O. Wilson
8. Tissue culture

Semester-III

BOT-501 Environmental Biotechnology & Management Full Mark: 80

Course objective: To acquired knowledge on how biotechnological approach can diminish various environmental problems with response to environmental pollution.

Content:

UNIT- I (20)

Introduction to environmental biotechnology, Biomass management, Energy plantation, Petro plants, Hydrocarbons from higher plants, Biogas, Bioethanol and bio-hydrogen production.

UNIT -II (20)

Bio-fertilizers: Types and importance of biofertilizer; Plant growth promoting bacteria, Biological control of pathogens, Bio-insecticides and bio-pesticides, heavy metals, Integrated pest management, Bio-safety and bioethics.

UNIT -III (20)

Bio-remediation: Principle, types and application bioremediation; Phyto-remediation: Method, types and significance of phytoremediation; Bioleaching: Process, factors influencing bioleaching; Bio-degradation of pollutants, Sewage treatment, Bio resources: their use and management.

UNIT -IV (20)

Environmental pollution: pollutants, classification of pollutants, pollution and its consequences, sources and effects of air pollution, water pollution, soil pollution, noise pollution, radioactive pollution, Management of air pollution, water pollution, soil pollution, noise pollution and radioactive pollution.

Course Outcome: Student will acquire knowledge on application of biotechnology in addressing workable environmental issues particularly environmental pollutions and their management.

Employability in Govt. & NGO and in every industry those need the challenges to neutralize their products or scraps threatening to environment

Recommended Books:

1. Sustainability Indicators: B Moldan *et al.* John Willey
2. Understanding Environmental Pollution- MK Hill: Cambridge Univ. Press
3. The Nature & Properties of Soil: NC Brady: MacMillan
4. Biology of Fresh Water: CF Mason: Longman
5. Ecology and Field Biology: RL Smith: Harper Collins, New York
6. Ecology: M. Begon, J Harper & Townsend: Blackwell Scientific
7. Fundamentals of Ecology: EP Odum: Saunders

Semester-III

BOT-503 Plant Diversity –III (Pteridophytes & Gymnosperms) Full Mark: 80

Course objective: To acquire the knowledge on vascular cryptogams and gymnosperms: their phylogeny and economic importance.

Content:

UNIT -I (20)

Characteristic features of Pteridophytes, Classification of pteridophyta, Origin of pteridophytes, Evolutionary trends among pteridophytes, Economic and ecological significance of pteridophytes; evolution of stele, heterospory and origin of seed habits.

UNIT -II (20)

Principles of palaeobotany, general accounts of fossil pteridophytes (Rhyniaceae, Psilophytaceae, Pseudosporochnaceae, Zosterophyllaceae, Asteroxylaceae), general account of Psilopsida (Psilophytales), Lycopsidea (Lycopodiales, Selaginellales, Isoetales), Sphenopsida (Equisetales), Pteropsida (Marattiales, Ophioglossales and Filicales).

UNIT -III (20)

General characteristics of gymnosperms, classification of gymnosperms, Origin and evolutionary trends among them, their distribution in India and economic importance of gymnosperms; Brief account of Pteridospermales (Lyginopteridaceae, Caytoniaceae) and Bennetitales (Cycadeoidaceae).

UNIT -IV (20)

General accounts, structure and reproduction in Cycadales (Cycadaceae), Coniferales (Pinaceae), Ginkgoales (Ginkgoaceae) and Gnetales (Gnetaceae).

Course Outcome: Students will be acquainted with vascular cryptogams and gymnosperms: their phylogeny and economic importance.

Recommended Books:

1. Biology & Morphology of Pteridophytes: Central Book Depot, Allahabad
2. The Morphology of Pteridophytes: KK Sporne, BI Publishing Pvt. Ltd. Mumbai
3. Gymnosperms: SP Bhatnagar & A. Moitra: New Age International
4. Gymnosperm: Structure & Evolution: CJ Chamberlain: CBS Publication, New Delhi
5. The Gymnosperms: C. Biswas & BM Johri: Narosa Publishing House

Semester-III

BOT- 505

Plant Metabolism-II

Full Mark: 80

Course objective: To gain knowledge about the various metabolic activities of plants.

Content:

UNIT -I (20)

Plant and water relation: Absorption of water. Water transport through xylem. Water movement from leaf to the atmosphere (transpiration), phloem transport (phloem loading and unloading), passive and active solute transport.

UNIT- II (20)

The plant hormones: Nature, physiological effects and mechanism of action of plant hormones (Auxins, Gibberellins, Cytokine. Ethylene and Abscissic acids) Stress physiology: Stressful environment, Response of plants to abiotic (Water, Temperature and saline stresses) and abiotic stresses.

UNIT- III (20)

Photosynthesis: General concept of photosynthesis. Photosynthetic apparatus, photosynthetic pigments and light harvesting complex, photolysis of water, mechanism of electron transport. CO₂ fixation-C₃, C₄ and CAM pathway, photorespiration and its significance.

UNIT- IV (20)

Respiration: General concept, Glycolysis, TCA cycle, Electron transport and ATP synthesis. Pentose phosphate pathway, Alhemute pathways.

Course Outcome: On successful completion of this course, the students will be able to learn the various metabolic activities of plants, which help them in employability in research field.

Recommended Books:

- | | | |
|---|--------------------------|---------------------------------|
| 1. Plant Physiology | FB Salisbury & CW Ross | Wadsworth Publishing |
| 5. Plant Metabolism | DT Dennis <i>et al</i> | Longman |
| 6. Biochemistry & Molecular Biology of Plant Hormones | PJJ Hooykaaset <i>al</i> | Elsevier, Amsterdam |
| 7. Introduction to Plant Physiology | WG Hopkins | John Wiley & Sons |
| 8. Molecular Cell Biology | H Lodishet <i>al</i> | WH Freeman |
| 9. Biochemistry & Physiology of Plant Hormones | TC Moore | Springer-Verlag |
| 11. Plant Physiology | Taiz & Zeiger | Sinaur Associates |
| 15. Biochemistry | Lehninger | International Book Distribution |

Semester-III

BOT-507

Biochemistry (Elective)

Full Mark: 80

Course objective: To learn the structure and function of various biological macromolecules. Specifically the structure, classification and properties of carbohydrate, amino acid, protein, lipid and nucleic acid.

Content:

UNIT- I

(20)

Biological Macromolecules (Biomolecules):The concept; Life as a complex organization of biomolecules; Origin and evolution of cellular macromolecules, properties of macromolecules; Composition, structure and function of biological macromolecules.

Carbohydrates:Classification, structure and properties of carbohydrates; Monosaccharides, Oligosaccharides and Polysaccharides.

UNIT -II

(20)

Amino Acids and Proteins: Amino acids- structure, classification and properties; Peptides and Proteins- classification, chemical bonds involved in protein structure, Protein configuration- primary, secondary, tertiary and quaternary structure.

UNIT -III

(20)

Lipids: General structure, classification and properties; Lipid biosynthesis and Oxidation- α -oxidation, β -oxidation and ω -oxidation; Glyoxylate cycle.

UNIT -IV

(20)

Nucleic Acids: General account of nucleic acids, nucleosides, nucleotides and its biosynthesis; Structure of DNA, Classes of DNA, Denaturation and renaturation of DNA; RNA and its types.

Course Outcome: By opting this course students will be able to learn the structure and function of various biological macromolecules. Specifically, they will know about the structure, classification and properties of carbohydrate, amino acid, protein, lipid and nucleic acid, which create employability in pharmaceutical industries.

Recommended Books:

- | | | |
|--|--------------------------|--|
| 1. Plant Physiology | FB Salisbury & CW Ross | Wadsworth Publishing |
| 2. Experiments in Plant Physiology | D. Bajracharya | Narosa Publication |
| 3. Introductory Practical Biochemistry | SK Sawhney & R. Singh | Narosa Publication |
| 4. Biochemistry & Molecular Biology of Plants | Buchanan <i>et al</i> | American Society for Plant Physiologists |
| 5. Plant Metabolism | DT Dennis <i>et al</i> | Longman |
| 6. Biochemistry & Molecular Biology of Plant Hormones | PJJ Hooykaaset <i>al</i> | Elsevier, Amsterdam |
| 7. Introduction to Plant Physiology | WG Hopkins | John Wiley & Sons |
| 11. Plant Physiology | Taiz & Zeiger | Sinaur Associates |
| 12. Tools in Biochemistry | TG Cooper | John Wiley |
| 13. Principles & Methods of Plant Molecular Biology, Biochemistry and Genetics | P Devi | Agrobios, Jodhpur |
| 14. Experimental Biochemistry | RL Dryer & GF Lata | Oxford Univ. Press |

Semester-III

BOT- 507

Biosystematics (Elective)

Full Mark: 80

Course objective: To know about the basic principles of ICN, techniques of plant identification and preservation.

Content:

UNIT -I

(20)

Systematics: scope and components criteria of classification of flowering plants, modern systems of classification and recent development, Phenetic and Cladistic approach. Evolutionary trends in Ranales. Umbellales, Lamiales, Polemoniales, Liliales, Microspetmae and Poales.

UNIT -II

(20)

Development of International code of Nomenclature for algae, fungi and plants. Frame work of ICN, nomenclature of taxa according to their ranks, typification, reterntion, choice and rejection of names and epithets, principle of priority and its limitations, names of hybrids, orthography of names and epithets.

UNIT -III

(20)

Application of systematic: herbarium concept, function and management, role of herbarium in plant identification, herbarium techniques, important herbaria and gardens of the world with special reference to Central National Herbarium, Indian Botanical garden. Ethnobotany: Concept and its role in drug discoveries.

UNIT -IV

(20)

Plant identification: methods of plant identification keys for identification of angiosperm plants, types of Botanical keys, method of preparation use of computers for identification taxonomic literature flora, monograph, manuals journal, indices and dictionaries.

Course Outcome: By studying the course students will learn the basic principles of ICN, techniques of plant identification and preservation. Very importantly students will acquire sound knowledge on evolutionary relationship among various angiospermic taxa, which help them to carry out future research.

Recommended Books:

- | | | |
|--|-----------------------|---------------------------------|
| 1. Handbook of Field Herbarium Methods | SK Jain & RR Rao | Today Tomorrow |
| 2. Taxonomy of Angiosperms | VN Naik | Tata McGrawHill |
| 3. Flora of Orissa (Four Volumes) | Saxena &Brahmam | OFDC, Bhubaneswar |
| 4. The Botany of Bihar & Orissa (3 Vols) | HH Haines | Bishen Singh & Mahinder Palsing |
| 5. New Concepts in Flowering Pl. Taxono | J Heslop-Harrison | Hienemann, London |
| 6. Handbook of Palynology | G Erdtman | Hafner, New York |
| 7. An Aid to ICBN | Henry & Chandra Bose | Today & Tomorrow Publication |
| 8. An Introduction to Plant Nomenclature | SSR Bennet | International Book Distribution |
| 9. Numerical Taxonomy | AJ Cole | Academic Press |
| 10. Principles of Angiosperm Taxonomy | PH Davis & VH Heywood | Robert E Kreiger |

Semester-III

BOT-507 Environmental Pollution & Management (Elective) Full Mark: 80

Course objectives: To acquaint with the concept of environment, factors affecting the environment, the sources of energy, environmental processes, disaster and the role of forest on management of environment.

Content:

UNIT -I (20)

Environmental Concept and definition: Components of the environment, function, Composition and structure of Atmosphere, Hydrosphere, Lithosphere and Biosphere, Environmental Factors: Light, Temperature, Precipitation Air and Soil.

UNIT -II (20)

Environmental & Energy: Non-conventional Solar energy, biogas, wind energy, ocean and tidal energy, geothermal energy, Conventional energy-coal, methanol, petroleum or mineral oil, hydroelectricity, nuclear power, wood and natural gas.

UNIT -III (20)

Environmental Processes & Disasters: Hydrological cycle, oxygen cycle, nitrogen cycle, carbon cycle, phosphate cycle, sulphur cycle, London smog, Mediterranean dead sea, Nuclear explosions, Minamata disease, Bhopal disaster, Chernobyl disaster, gulf war hazards.

UNIT -IV (20)

Environment & Forest: Importance of forest, forest types, deforestation, causes of deforestation, consequences of deforestation, forest conservation, afforestation, reforestation, social forestry and agro forestry.

Course Outcome: Students will able to learn the concept and various segments of environmental factors affecting the environment. They will also know the sources of energy, different environmental processes, disaster and the role of forest on management of environment with employability in academia and future research.

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. Understanding Environmental Pollution- MK Hill: Cambridge Univ. Press
9. The Nature & Properties of Soil: NC Brady: MacMillan
10. Biology of Fresh Water: CF Mason: Longman
11. A Text Book of Plant Ecology: Ambasht&Ambasht: Vikash Publishing
12. Modern Concept of Ecology: HD Kumar: Vikash Publishing

Semester-III

BOT-507 Industrial Microbiology (Elective) Full Mark-80

Course objectives: To acquire basic knowledge on industrial microbiology, techniques of microbe's culture, screening and preparation of inoculums for various industrial processes including the fermentation mechanism.

Content:

Unit -I (20)

History, milestones and development of industrial microbiology, classification of microorganisms with special reference to bacteria, culture media for bacteria, fungi and algae; pure culture techniques, maintenance and preservation of microbes.

Morphology and fine structure of bacteria, bacterial nutrition, batch and continuous culture, bacterial growth curve, mathematical modeling of bacterial growth, factors regulating bacterial growth; General properties of viruses, virus cultivation, assay and preservation.

Unit -II (20)

Microbiology of soil, water and air, biogeochemical cycles, biological nitrogen fixation, biofertilizers, microbial inoculants, production of microbial inoculants, safety, advantages and disadvantages.

Unit -III (20)

Production strains, screening techniques of industrially important microorganisms, strain development, production media, raw-materials, screening for production media, preparation of inoculums for industrial processes.

Unit -IV (20)

Fermenter, types of fomenters, design and application of fomenters, downstream processing and product recovery, fermentation, factor regulating fermentation processes, pasteurization.

Course Outcome: Students will acquire basic knowledge on the general morphology, characteristics and growth of bacteria and viruses. They will also learn various techniques of microbes culture, screening and preparation of inoculums for various industrial processes including the fermentation mechanism.

Recommended Books:

1. Microbiology-An Introduction: GJ Tortora, BR Funck & 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. 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
9. Food Microbiology: J James: Blackwell Scientific Publication
10. Basics of Plant Virology: HN Verma: Oxford IBH Publishing Company

BOT-509 Practical pertaining to theory papers 503 & 505

Full Mark: 100

1. Local field trips to acquaint the students with occurrence of Pteridophytes and Gymnosperms at different habitats in nature and collection of specimens.
2. Preparation of temporary and/or permanent slides and study of vegetative and reproductive structures of membranes of different classes of Pteridophytes and Gymnosperms: Submission of specimens and permanent slides.
3. Study of fossil materials
4. Preparation of plant tissue culture medium, sterilization and disinfection, Callus proliferation, shoot and root regeneration and transfer of axenically grown plants to soil, preparation of synthetic seed.
5. To measure size of stomata using ocular and stage micrometer.
6. To determine the total chlorophyll pigment content of supplied leaf samples spectrophotometrically.
7. To compare the chlorophyll-a & chlorophyll-b ratio in C3 and C4 plants.
8. Determination of the reducing sugar content of supplied sample spectrophotometrically.
9. Determination of the amino acid content of supplied sample by ninhydrin method.
10. Estimation of the protein content of the supplied sample by Lowry method.
11. Determination and comparison of total dissolved oxygen content of water of different water bodies.
12. Determination and comparison of total dissolved carbon dioxide content of water of different water bodies.

Semester IV

BOT-502 Plant Biotechnology & Genetic Engineering Full Mark: 80

Course objectives: To acquaint with the plant tissue culture technique, transgenic plants and they can also able to understand the general overview on scope of biotechnology and recombinant DNA technology.

Content:

UNIT -I (20)

Plant tissue culture: General methodology of plant tissue culture, Laboratory requirements, Aseptic techniques, Suspension culture: History, method and commercial application of suspension culture, Haploid production, anther and isolated pollen culture.

Somatic embryogenesis, Factors affecting somatic embryogenesis, Synthetic seeds, Somaclonal variation, Origin of somaclonal variation, Mechanism underlying genetic variation, Significance.

UNIT -II (20)

Protoplast isolation, Viability of protoplasts, Protoplast culture, Somatic hybridization and cybridization, Protoplast fusion, Chemical fusion, Electrofusion, Selection of fusion products, Verification of hybridity.

UNIT -III (20)

Plant transformation technology, *Agrobacterium tumefaciens* – mediated transformation, crown gall and hairy root diseases, Basis of crown gall and hairy root formation, features of Ti& Ri plasmids, T-DNA region and T-DNA transfer, Selectable markers and reporter genes, selection and identification of transgenic plants, Herbicide resistance, Insect resistance.

UNIT -IV (20)

Biotechnology an overview, scope and commercial potential, Recombinant DNA technology: Restriction endonucleases, Vectors: Definition, properties, types (plasmida, phage, cosmid, BAC and YAC); introduction of the vectors into a suitable host, selection of recombinant clones, construction and screening of genomic and cDNA library.

Course Outcome: Students will be acquainted with the technique of plant tissue culture and also know how to produce transgenic plants through agro-bacterium mediated transformation technology. They can able to understand the general overview on scope of biotechnology and recombinant DNA technology.

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-IV

BOT-504

Biochemistry (Elective)

Full Mark: 80

Course objectives: To gain knowledge on the basic concept of biological energy transformation and transduction, the nature, concept and types of various secondary metabolites.

Content:

UNIT- I (20)

pH and Buffer: Ionization of water, Weak Acids and Weak Bases; The pH scale, Buffer and Buffer Systems, Henderson and Hesselbalch equation.

UNIT -II (20)

Bioenergetics: Concept of energy, Biological energy transformation; Laws of thermodynamics- The First and Second Law of Thermodynamics; Free energy changes, Entropy and Enthalpy.

UNIT -III (20)

Energy Transduction: Energy transducing membranes, Compartmentalization of energy transducing membranes, ATP Synthesis- Chemiosmotic theory and Mitchell hypothesis.

UNIT -IV (20)

Secondary Metabolites: Primary and secondary metabolites; Types of secondary metabolites- Terpenes, Phenolics and Alkaloids, Functions of secondary metabolites

Course Outcome: By learning this course students will acquire knowledge on the basic concept of biological energy transformation and transduction. Most interesting and valuable application of this course outcome is students will learn the nature, concept and types of various secondary metabolites.

Course Outcome: By learning this course students will acquire knowledge on the basic concept of biological energy transformation and transduction. Most interesting and valuable application of this course outcome is students will learn the nature, concept and types of various secondary metabolites.

Recommended Books:

Plant Physiology	FB Salisbury & CW Ross	Wadsworth Publishing
Experiments in Plant Physiology	D. Bajracharya	Narosa Publication
Introductory Practical Biochemistry	SK Sawhney & R. Singh	Narosa Publication
Biochemistry & Molecular Biology of Plants	Buchanan <i>et al</i>	American Society for Plant Physiologists
Plant Metabolism	DT Dennis <i>et al</i>	Longman
Biochemistry & Molecular Biology of Plant Hormones	PJJ Hooykaas <i>et al</i>	Elsevier, Amsterdam
Introduction to Plant Physiology	WG Hopkins	John Wiley & Sons
Molecular Cell Biology	H Lodish <i>et al</i>	WH Freeman
Biochemistry & Physiology of Plant Hormones	TC Moore	Springer-Verlag

Semester-IV

BOT-504

Biosystematics (Elective)

Full Mark: 80

Course objectives: To learn the various branches of plant systematic such as pollynology, cytotaxonomy, Molecular biology, Numerical taxonomy etc. by adopting modern biotechnological approaches.

Content:

UNIT -I

(20)

Cytotaxonomy: biological species concept, genetics of population, chromosome number, karyotype, levels of polyploidy. Role of cytogenetics in plant taxonomy.

Chemotaxonomy: uses of chemical criteria in plant taxonomy, primary metabolites, secondary metabolites and semantides, use of phytochemical criteria such as flavonoides, alkaloids, terpenoides, serology in taxonomy.

UNIT- II

(20)

Use of palynological data in taxonomy, pollen characters as taxonomic values. Molecular axonomy: application of molecular markers for identification of species and cultivars, phylogeny and establishment of genomic relationship in resolving taxonomic problems.

UNIT -III

(20)

Numerical taxonomy: concepts, characters and attributes, OTU's, cluster analysis. Origin of cultivated plants, wild relatives of major crop plants in India, germplasm conservation: *in situ* and *ex situ* conservation, role of gene banks; taxonomy of cultivated plants and hybrids.

UNIT -IV

(20)

Floristic studies: methods, collection of materials, documentation of data, preservation and transfer of data, Endemism: concepts and types of endemism, hotspots; brief account of floristic studies in Odisha with special reference to mangrove vegetation and flora of Similipal Biosphere Reserve. Classification Mangrove species based on their physiological adaptation.

Course Outcome: Student will able to learn the various branches of plant systematic such as pollynology, cytotaxonomy, Molecular biology, Numerical taxonomy etc. They will able to learn the methods of floristic study and how to conserve germplasm adopting modern biotechnological approaches.

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 st Century | B Nordenstam, Gazaly, Kassar | Port Press Ltd., London |
| 7. Fundamentals of Plant Systematics | AE Radford | Harper & Row Publications |
| 8. Plant Taxonomy & Systematics 2 nd 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-IV

BOT-504 Environmental Pollution & Management (Elective) Full Mark-80

Course objectives: To acquire knowledge on different environmental pollution and their management strategies.

Content:

UNIT -I (20)

Environment & Pollution: Definition of environmental pollution and pollutant, classification of pollution and pollutant, pollution and its effects on plants, animals, human beings and on materials, synergism and antagonism, Entry of pollutant into the environment, transfer of pollutant, abiotic transformation of pollutant, entry of pollutant into biosphere, bio-accumulation and bio-magnification, biodegradation of pollutants.

UNIT -II (20)

Air Pollution & Management: Normal composition of clean air, air pollution sources, deforestation, burning of fossil fuels, vehicular emission, rapid industrialization, agricultural activities and wars, effects of air pollution on biota, manufactured goods, aesthetic loss, global warming or green house effect, acid rain, ozone layer depletion, control of air pollution.

UNIT -III (20)

Water pollution & Management: Major water pollutant, sources of water pollution, point sources, non-point sources, industrial discharge, domestic sewage, agricultural waste, surface runoff, oil discharge, hot water discharge, radio-active wastes. Effects of water pollution on biota, Eutrophication, marine pollution, preservation and control of water pollution.

UNIT -IV (20)

Sources, effects and control of Soil pollution, Noise pollution, Radiation/Radio-active pollution, Importance of Environmental Impact Assessment; Role of Pollution Control Board to control environmental pollution.

Course Outcome: Students will understand and acquire knowledge on environmental pollution and their management strategies.

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-IV

BOT-504

Industrial Microbiology (Elective)

Full Mark-80

Course objectives: To aware on the techniques of microbial assay, industrial production of antibiotics, enzyme, vitamins, amino acids, vaccine etc. and also to learn the methods and principles of food preservation, microbes in waste management, production and use of genetically modified organisms (GMMOs) and bioterrorism.

Content:

UNIT- I

(20)

Microbial assay- Factors governing microbial assay techniques; microbial assay of vitamins and amino acids; advantages and disadvantages of microbiological assay; automation of microbial assay.

Industrial production of antibiotics, organic acids, amino acids, alcohol, vitamins, vaccines, solvents, SCP, enzyme, enzyme technology and immobilization of enzyme.

UNIT- II

(20)

Microbial contamination of different foods, methods and principles of food preservation, indicator of food sanitary quality, microbiology of milk and milk products, fermented foods, alcoholic beverages and other microbial derived food products.

UNIT -III

(20)

Microbial derived insecticides and pesticides, advantages and disadvantages, future prospects, microbial biotransformation, bioremediation, bioleaching, microbes in pollution control, microbes in renewable energy production.

UNIT -IV

(20)

Role of microbes in waste treatment, solid waste management, microbes in degrading of hazardous compounds, genetically modified microorganisms (GMMOs), use of GMMOs in industries, biosensors, biochips, bioterrorism.

Course Outcome: Students will be able to understand the techniques of microbial assay, industrial production of antibiotics, enzyme, vitamins, amino acids, vaccine etc. They will also learn the methods and principles of food preservation. They can know the role of microbes in waste treatment, solid waste management, production of genetically modified organisms (GMMOs) and use of GMMOs in industries, biosensor, biochips and bioterrorism

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. General Microbiology: Stanier: Blackwell Scientific Publication
5. Kuby Immunology: RA Goldsby, J Thomas: Freeman
6. Immunology: Roitt: John Wiley

Semester-IV

BOT-506

Elective Practical (Biochemistry)

Full Mark-100

1. Determination of reducing sugars using Nelson-Somogyi or 3, 5-dinitrosalicylic acid method.
2. Determination of total sugars content of supplied sample using Anthrone reagent method.
3. Estimation of amino acids by Ninhydrin reagent method.
4. Estimation of protein by Lowry's/Bradford's method.
5. Estimation of DNA by Diphenylamine method.
6. Estimation of RNA by Orcinol method.
7. Demonstration and separation of protein by native Disc-gel electrophoresis.
8. Demonstration and separation of protein by SDS-PAGE (slab gel) electrophoresis.
9. Demonstration and separation of nucleic acid by Agarose gel electrophoresis.
10. Preparation of buffer of definite pH.

Semester-IV

BOT-506

Elective Practical (Biosystematics)

Full Mark-100

1. Herbarium methodology : Collection, Identification, Preservation, Mounting and Housing
2. Preparation of field notes and submission of observational data on vegetational types, distribution and significant notes in the form of field note book.
3. Phytography, consultation of botanical keys for identification and formulation of dichotomous keys.
4. Application of articles of ICN for determination of correct names of taxa, author citation and protolodue.
5. Germplasm collection and study of endemic taxa.
6. Study of anatomical, embryological and palynological methods applied to taxonomic problems.
7. Cytological analysis for determination of chromosome number, nature of polyploidy, karyotypic analysis in relation to taxonomic study.
8. Study of genomic relationship RAPD, RFLP markers.
9. Study on distribution pattern of proteins and amino acids by qualitative and quantitative methods.
10. Submission of herbarium specimen pertinent to :
 - a. Different ecological habitats
 - b. Biosystematic studies
 - c. Application of articles of ICN
 - d. Wild relatives of crop plants
 - e. Potential medicinal plants
 - f. Formulation of botanical keys

Semester-IV

BOT-506 Elective Practical (Environmental Pollution & Management) Full Mark-100

1. Determination of total dissolved solids of water
2. Determination of dissolved oxygen concentration of water sample.
3. Determination of free carbon dioxide content of water of different water bodies.
4. Determination of Biological Oxygen Demand (BOD) of sewage sample.
5. Determination of Chemical Oxygen Demand (COD) of sewage sample.
6. Determine the efficiency of removal of air pollutant using fibrous air filter.
7. Effect of Sulphur dioxide on crop plants
8. Estimation of heavy metals in water/soil by Atomic Absorption Spectrophotometry.
9. Estimation of nitrate in drinking water.
10. Study of soil profile with respect to pH, moisture content, porosity and organic carbon content.
11. Study of water bodies and its pollution loads taking parameters like pH, DO content, free CO₂, BOD, COD, Acidity, Alkalinity and phosphate and nitrate content.

Semester-IV

BOT-506 Elective Practical (Industrial Microbiology) Full Mark-100

1. Learning about safety rules, basic requirements, methods of sterilization preparation of culture media; Study of microscope and micrometry.
2. Demonstration and study of techniques for pure culture of microorganisms.
3. Techniques for isolation and enumeration of microorganisms from different habitats.
4. Study of maintenance and preservation of microorganisms.
5. Staining techniques (simple and differential) for identification of microorganisms.
6. Bacterial growth curve studies by turbidometric and cell count method.
7. Study of effect of environmental factors on bacterial growth.
8. Biochemical techniques for identification of selected bacteria.
9. Microbial examination of water for potability.
10. Isolation, cultivation and identification of *Rhizobium*, *Azotobacter*, and *Azospirillum* from soil and associated host.
11. Antibiotic sensitivity test for bacteria and fungi on agar plate by disc diffusion method.
12. Study of antibiotic assay techniques.
13. Determination of Minimum Inhibitory Concentration (MIC) of antimicrobial compounds.
14. Microbiological examination of milk and milk products.
15. Isolation, culture and identification of microbes from contaminated food sample.
16. Screening of microbes (Bacteria and Fungi) for different industrial enzymes.
17. Study of production of alcohol and organic acids by microorganisms.

Semester-IV

BOT- 508 Project

Full Mark: 100

Each student is required to carry out a project work involving either experimental research work or a review work under the supervision of a faculty member and submit a dissertation. The student has to start the project work from Semester- III, continue the work in Semester IV and submit the dissertation before the commencement of Semester IV theory examination. The project will be evaluated in Semester IV. The student has to give a Power Point Presentation in the presence of an external examiner and an internal examiner (the Supervisor). The project will be evaluated by the examiners based on the dissertation (50 marks), Power Point Presentation (25 marks) and viva-voce (25 marks).

Skill development with long term hands - on -training on various bio-techniques i.e. microbial, plant tissue culture, plant systematic, biodiversity conservation, environmental management along with data analysis software training for further research and development in Industries, Institutes and Academics