



**List of Courses Focus on Employability/ Entrepreneurship/
Skill Development**

Department : Botany

Programme Name : Integrated UG/PG Honours

Academic Year : 2021-22

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	BOUBTG2	Food Science
02.	BOUBTG3	Community Forestry
03.	BOUBTG4	Seed Technology
04.	BOUBTG7	Environmental Monitoring and Management
05.	BOUETD1	Bioinformatics
06.	BOUETD2	Natural Resource Management
07.	BOUETD9	Horticulture Practices
08.	BOUCTL1	Bio-fertilizers
09.	BOUCTL2	Herbal Technology
10.	BOUCTL3	Mushroom Culture Technology
11.	BOUCTL4	Nursery and Gardening
12.	BOUCTL5	Environmental impact analysis
13.	BOUCTL6	Agriculture and Food Microbiology
14.	BOUCTL7	Floriculture
15.	BOPCTD8	Agricultural Microbiology
16.	BOPBTD2	Bio fertilizer and Biopesticides Technology
17.	BOPDTD16	Ethno-Pharmacognosy and Nutraceuticals
18.	BOPDTD17	Food Microbiology
19.	BOPCTD11	Herbal Cosmetics



20.	BOPBTD5	Herbal Product Development and Formulation
21.	BOPCTD13	Plant Propagation and Nursery Development
22.	BOPDAT01	Bio-Business and Entrepreneurship
23.	BOPDAT02	Ecosystem Services and Biodiversity

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Signature & Seal of HoD



Scheme and Syllabus

SCHOOL OF SCIENCES: (LIFE SCIENCE) B.Sc. (BOTANY) Hon's

SEMESTER I

Semester	Course Opted	Course Code	Name of the course	Credit	Hour / week	End semester marks	Internal Marks	Total marks
Semester I	Core-1	BOUATT1	Phycology and Microbiology	4	4	70	30	100
	Core-1 Lab	BOUALT1	Lab based on core 1	2	4	70	30	100
	Core-2	BOUATT2	Bio-molecules and cell Biology	4	4	70	30	100
	Core-2 Lab	BOUALT2	Lab based on core 2	2	4	70	30	100
	Generic Elective-1 (GE- 1)	BOUATG	Opted from the basket	4	4	70	30	100
	Generic Elective-1 Lab	BOUALG	Lab based on GE-1	2	4	70	30	100
	Ability Enhancement Compulsory Course-1 (AECC)	BOUATA1	English Communication	4*	4	70	30	100
	ECA	BOUALS1	ECA- Extracurricular activity/ Tour, Field visit/ Industrial training/ NSS/ Swachhta/ vocational Training/ Sports/	2	(2)	70	30	100



		others						
		TOTAL	24	28				800

SEMSTER II

Semester II	Core-3	BOUBTT1	Mycology and Phytopathology	4	4	70	30	100
	Core-3 Lab	BOUBLT1	Lab based on core 3	2	4	70	30	100
	Core- 4	BOUBTT2	Archegoniate	4	4	70	30	100
	Core- 4 Lab	BOUBLT2	Lab based on core 4	2	4	70	30	100
	Generic Elective-2 (GE-IB)	BOUBTG	Elective from the Basket	4	4	70	30	100
	Generic Elective-2- Lab	BOUBLG	Lab based on GE-2	2	4	70	30	100
	Ability Enhancement Compulsory Course-2 (AECC)	BOUBTA2	Environmental Science	4*	4	70	30	100
	ECA	BOUBLS1	ECA-Extracurricular activity/ Tour, Field visit/ Industrial training/ NSS/ Swachhta/ vocational Training/ Sports/ others	2	(2)	70	30	100
		Total	24	28			800	

SUMMER Internship: 15 days

BOUBEF1	Swayam/Swachhta / NSS / Industrial/ others	2	100	70	30	100
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SEMESTER III

Semester III	Core- 5	BOUCTT1	Anatomy of Angiosperm	4	4	70	30	100
	Core- 5 Lab	BOUCLT1	Lab based on core 5	2	4	70	30	100
	Core- 6	BOUCTT2	Economic Botany	4	4	70	30	100
	Core- 6 Lab	BOUCLT2	Lab based on core 6	2	4	70	30	100
	Core- 7	BOUCTT3	Genetics	4	4	70	30	100
	Core- 7 Lab	BOUCLT3	Lab based on core 7	2	4	70	30	100
	Generic Elective-3 (GEII-A)	BOUCTG	Elective from the Basket	4	4	70	30	100
	Generic Elective-3- Lab	BOUCLG	Lab based on GE-3	2	4	70	30	100
	Skill Enhancement Course (SEC-1)	BOUCTL	From the Basket	2	2	70	30	100
	Skill Enhancement Course (SEC-1) Lab/Training/f field visit	BOUCLL	Lab Based on the selected course	2	2	70	30	100



			Total	28	34			1000
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SEMESTER IV

Core- 8	BOUDDT1	Molecular Biology	4	4	70	30	100
Core- 8 Lab	BOUDLT1	Lab based on core 8	2	4	70	30	100
Core- 9	BOUDDT2	Plant Ecology and Phytogeography	4	4	70	30	100
Core- 9 Lab	BOUDLT2	Lab based on core 9	2	4	70	30	100
Core-10	BOUDDT3	Plant Systematics	4	4	70	30	100
Core-10 Lab	BOUDLT3	Lab based on core 10	2	4	70	30	100
Generic Elective- 4 (GEII-B)	BOUDTG	Elective from the Basket	4	4	70	30	100
Generic Elective-4- Lab	BOUDLG	Lab based on GE-3	2	4	70	30	100
Skill Enhancement Course (SEC - 2)	BOUDTL	From the SEC basket	2	2	70	30	100
Skill Enhancement Course (SEC-2) Lab/Training /field visit	BOUCLL	Lab Based on the selected SEC course	2	2	70	30	100
TOTAL			28	34			1000

SUMMER Internship: 15 days

SUMMER Internship: 15 days	BOUDEF1	SwayamSwachhta / NSS / Industrial/ others	2	100	70	30	100
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SEMESTER V

Core-11	BOUETT1	Reproductive Biology of Angiosperm	4	4	70	30	100
Core -11 Lab	BOUELT1	Lab based on core 11	2	4	70	30	100
Core -12	BOUETT2	Plant Physiology	4	4	70	30	100
Core -12 Lab	BOUELT2	Lab based on core 12	2	4	70	30	100
Discipline Specific Elective (DSE-1)	BOUETD	From the DSE basket	4	4	70	30	100
DSE-1 - Lab	BOUELD	Lab based on DSE-1	2	4	70	30	100
Discipline Specific Elective (DSE-	BOUETD	From the DSE basket	4	4	70	30	100



2)								
DSE-2 - Lab	BOUELD	Lab based on DSE-2	2	4	70	30	100	
		TOTAL	24	32			800	

SEMESTER VI

Semester VI	Core-13	BOUFTT1	Plant Metabolism	4	4	70	30	100
	Core -13 Lab	BOUFLT1	Lab based on core 13	2	4	70	30	100
	Core -14	BOUFTT2	Plant Biotechnology	4	4	70	30	100
	Core -14 Lab	BOUFLT2	Lab based on core 14	2	4	70	30	100
	Discipline Specific Elective (DSE-3)	BOUETD	From the DSE basket	4	4	70	30	100
	DSE-3 - Lab	BOUELD	Lab based on DSE-3	2	4	70	30	100
	Dissertation/ Project work followed by seminar	BOUFDT1	Dissertation/ Project work followed by seminar	5 +1=6	8	140	60	200
			TOTAL	24	32			800
		TOTAL CREDITS	152 + 4 (SI)					

Course offered by Botany

(Course Basket)

Generic Electives

Sn	Course (General Electives)	Course code
1.	Environmental Technology	BOUBTG1
2.	Food Science	BOUBTG2
3.	Community Forestry	BOUBTG3
4.	Seed Technology	BOUBTG4
5.	Plant-Microbes Interaction	BOUBTG5
6.	Environmental Microbiology	BOUBTG6
7.	Environmental Monitoring and Management	BOUBTG7
8.	Global Environmental Issues	BOUBTG8



9.	Algal Biotechnology	BOUBTG9
10.	Global Climate change	BOUBTG10

Discipline Specific Electives

Sn	Course (Discipline Specific Electives)	Course code
1.	Bioinformatics	BOUETD1
2.	Natural Resource Management	BOUETD2
3.	Industrial and Environmental Microbiology	BOUETD3
4.	Biostatistics	BOUETD4
5.	Aquatic Botany	BOUETD5
6.	Bio-Analytical Techniques	BOUETD6
7.	Environmental Microbiology and Biotechnology	BOUETD7
8.	Plant Biotechnology and Genetic Engineering	BOUETD8
9.	Horticulture Practices	BOUETD9

Skill enhancement courses

Sn	Course (Discipline Specific Electives)	Course code
1.	Bio-fertilizers	BOUCTL1
2.	Herbal Technology	BOUCTL2
3.	Mushroom Culture Technology	BOUCTL3
4.	Nursery and Gardening	BOUCTL4
5.	Environmental impact analysis	BOUCTL5
6.	Agriculture and Food Microbiology	BOUCTL6
7.	Floriculture	BOUCTL7
8.	Forensic Botany	BOUCTL8

Ability Enhancement Course Compulsory

1. English/MIL Communication
2. Environmental Science



M.Sc. (BOTANY)

SEMESTER I

Semester	Course Opted	Course Code	Name of the course	Credit	Hour / week	End semester marks	Internal Marks	Total marks
Semester I	Core-1	BOPATT1	Advances in Virus, bacteria and Algae	3	3	70	30	100
	Core-1 Lab	BOPALT1	Lab based on core 1	2	4	70	30	100
	Core-2	BOPATT2	Applied Mycology and Advance Phytopathology	3	3	70	30	100
	Core-2 Lab	BOPALT2	Lab based on core 2	2	4	70	30	100
	Core-3	BOPATT3	Advances in Bryophytes, Pteridophytes and Gymnosperm	3	3	70	30	100
	Core-3 Lab	BOPALT3	Lab based on core 3	2	4	70	30	100
	Core-4	BOPATT4	Cell and Molecular Biology	3	3	70	30	100
	Core-4 Lab	BOPALT4	Lab based on core 4	2	4	70	30	100
			TOTAL		20			

SEMESTER II

Semester II	Core-5	BOPBTT5	Taxonomy of Angiosperm	3	3	70	30	100
	Core-5 Lab	BOPBLT5	Lab based on core 5	2	4	70	30	100
	Core- 6	BOPBTT6	Plant Biochemistry	3	3	70	30	100
	Core- 6 Lab	BOPBLT6	Lab based on core 6	2	4	70	30	100
	Core- 7	BOPBTT7	Ecology and Environment	3	3	70	30	100
	Core- 7 Lab	BOPBLT7	Lab based on core 7	2	4	70	30	100
	Discipline specific Elective	BOPBTD	DSE from the Basket 1	3	3	70	30	100
	Discipline specific Elective Lab	BOPBLD	Lab based on DSE1	2	4	70	30	100
			Educational Tour (one week duration) (BOPBLF1)	2				



		Total	22				800
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SEMESTER III

Semester III	Core- 8	BOPCTT8	Plant Anatomy and Reproductive Biology	3	3	70	30	100
	Core- 8 Lab	BOPCLT8	Lab based on core 5	2	4	70	30	100
	Core- 9	BOPCTT9	Genetics and Cytogenetics	3	3	70	30	100
	Core- 9 Lab	BOPCLT9	Lab based on core 8	2	4	70	30	100
	Core- 10	BOPCTT10	Plant physiology	3	3	70	30	100
	Core- 10 Lab	BOPCLT10	Lab based on core 9	2	4	70	30	100
	Discipline specific Elective	BOPCTD	DSE from the Basket 2	3	3	70	30	100
	Discipline specific Elective Lab	BOPCLD	Lab based on DSE 2	2	4	70	30	100
	Research Methodology (RM11)	BOPCTT11	University common course	4	4	70	30	100
	Seminar (BOPCST5)			2				50
Total			26				950	

SEMESTER IV

	Discipline specific Elective	BOPDTD	DSE from the Basket 3	3	3	70	30	100
	Discipline specific Elective Lab	BOPDLD	Lab based on DSE 3	2	4	70	30	100
	Open Elective (OE 1)	BOPDTO	From the OE basket	3	3	70	30	100
	Open Elective Lab (OE 1)	BOPDLO	Lab based on the selected OE course	2	4	70	30	100
	Dissertation/ Project work	BOPDDT1	Dissertation/ Project work followed by seminar	6		140	60	200



TOTAL

16

600

Discipline specific Elective offered by Botany

(Discipline specific Elective Basket)

Basket 1 (Semester II)	Basket 2 (Semester III)	Basket 3 (Semester IV)
Algae, Environment and Human Welfare	Agricultural Microbiology	Environmental Pollution
Biofertilizer and Biopesticides Technology	Biodiversity and Conservation	Ethno-Pharmacognosy and Nutraceuticals
Bioinformatics and Evolutionary Biology	Ethnobotany and Traditional knowledge	Food Microbiology
Environmental Microbiology	Herbal Cosmetics	Global Change Biology
Herbal Product Development and Formulation	Microbial Technology	Microbial Genetics
Microbial Physiology	Plant Propagation and Nursery Development	Plant Functional Genomics
Plant Stress Biology	Plant Tissue Culture and Application	Plant Systematics
		Plant Diversity, Uses and Conservation

Course- baskets are dynamic in nature. Courses present in one basket can be shifted to another basket as per the requirement and availability of resources.



OPEN ELECTIVE

1. Bio-Business and Entrepreneurship
2. Ecosystem Services and Biodiversity

B.Sc. Botany

General Elective course II: Food Science

Course code: BOUATG2

(Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Learning outcomes:

After the end of the course, the students will be able to:

Classify the proteins, lipids and Minerals in food chemistry

Recognize Sources of microorganisms and food borne illness

Evaluate the food Processing industries and preservation techniques

Comprehend the interrelationships among different components of beverages technology and Check Food Packaging

Assess food laws and quality control at international standards

Classify into harmful and beneficial bio-colors, flavors, vitamins, bio-preservatives, antibiotics and industrial alcohol

Keywords:

Food chemistry, Food microbiology, Food toxins, Food safety, Quality control, Nutrition, Genetically modified foods

Unit I

7 lectures

Food Chemistry: Sources and Classification of Carbohydrates, proteins, lipids and Minerals. Participation in metabolic pathways.

Unit II

8 lectures

Food Microbiology: Sources of microorganisms in food, Principles of food spoilage, food borne illness. Food Processing: Dairy industry, Fruit processing, meat industry, processing and preservation. Beverages technology: Coffee, beer and wine etc.

Unit III

8 lectures

Nutrition, Nutraceuticals and functional foods: Classification and characteristics of functional foods. Processing technology and incorporation. Food Toxins: Natural, microbial and chemical toxins in food processing. Food Packaging: Aseptic and Packaging of specific foods, fruits, vegetables, dairy products, cereals snacks etc.

Unit IV

7 lectures

Food laws and quality control: Food safety and standard act (2006) and other Indian and International standards. Food Biotechnology: Biotechnology in food industry,



production of biocolours, flavours, vitamins, biopreservatives, antibiotics and industrial alcohol. Genetically modified foods.

Lab (BOUALG2)

1. Non thermal and thermal methods of food preservations
2. Meat and Poultry processing technology
3. Post-harvest technology at small scale
4. Food drying
5. Fermentation technology
6. Project work
7. Industrial visit
8. Fruit and vegetables processing
9. Determination of
 - a) Moisture of food samples
 - b) Protein
 - c) ash
 - d) Fat
 - e) Sugars- reducing and non-reducing

Generic Elective Course III: Community Forestry

Course code: BOUATG3

(Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Learning outcomes:

After completion of the course, the students will be able to;

Understand community forestry and its conservation

Examine the use of trees and community forestry

Interpret the role of indigenous/ tribal people in conservation of forest

Examine the role of various community forestry conservation programs

Measure the different properties of trees such as wood volume, age, height, volume etc.

Keywords:

Community forestry, Commercial forestry, Conservation, Land uses, Timber harvesting

Unit I

8 lectures

Defining community forestry and conservation, Indigenous community-based forestry systems and their changes, Case studies of indigenous forest management systems: India. , History of commercial forestry in India, Diseases of commercial forestry, maintenance



of forests, Protection from fire, illicit felling, Measurement of Trees- Height, girth, wood density, wood quality, clear and selective felling.

Unit II

8 lectures

Role of community forestry in Environmental conservation, Water shed management, soil management and poverty reduction, Trees as a forest management tool: managing vegetation to modify climate, soil conditions & ecological processes, Social considerations on land-uses.

Unit III

7 lectures

State-sponsored community forestry and conservation programs, Changing paradigms in forestry and environmental conservation, Community- managed commercial timber harvesting.

Unit IV

7 lectures

Community-based forestry and collaborative conservation in India, factors contributing to the rise of community forestry, Role of tribes in Forest and management.

Lab (BOUALG3)

1. Methods of measurement of wood volume of standing trees and logs, wood density, specific gravity, yield, and non woody products.
2. Protection of woody and non woody plants from fire and pathogens.
3. Measurement of Trees using different methods
 - i. Total Height
 - ii. Bole Height
 - iii. dbh
 - iv. Volume (with and w/o bark) of standing trees
 - v. Age
4. Properties of wood: density
5. Counting of number of trees through various methods
6. Statistical analysis of the data

Generic Elective Course IV: Seed Technology

Course code: BOUATG4

(Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Learning outcomes:

After completion of the course, the students will be able to;
Understand the theoretical orientation of seed development
Analyse the different ways of seed processing in different plants
Examine the various methods of Seed testing
Understand the method of seed production in different plants



Explain the concept of hybrid seed production

Keywords:

Seed development, Seed morphology, Seed dormancy, Seed testing, Seed entomology, Seed storage and Viability

Unit I

8 lectures

Theory of seed development and morphology, Principles of seed production in agricultural crops, seed production in vegetables, fruits, flowers, forage and fodder crops. Seed Dormancy- possible reasons and methods of breaking of dormancy.

Unit II

8 lectures

Concept of seed processing, diversity in seed storage and viability issues, Methods of testing of seed viability. Behaviour of seed germination and concept of speed of germination/seed vigour, design of experiments for evaluation of seed related traits

Unit III

7 lectures

Methods used for seed testing, ISTA (International Seed Testing Association) Rules procedure of seed certification and quality control, basis outlines of seed pathology and seed entomology.

Unit IV

7 lectures

Economics of seed production and marketing, seed production in medicinal and aromatic plants, Concept of hybrid seed and production

Lab (BOUALG4)

1. Seed viability testing
2. Seed moisture analysis
3. Seed priming for breaking seed dormancy
4. Seed constituents analysis
5. Seed germination studies ; monocots , dicots
6. Synthetic seed development

7. Generic Elective Course VII: Environmental Monitoring and

8. Management

9. Course code: BOUATG7

10. (Credits: Theory-4, Practical-2)

11. THEORY (Lectures: 60)

12.

13. Learning outcomes:

14. On the completion of the course the students shall be able to
15. Understand the fundamental concepts of environmental monitoring and management
16. Analyze the different methods of air, water, and soil quality monitoring process



17. Examine different environmental management systems and trade related intellectual properties (TRIPs), intellectual property rights (IPRs).
18. Evaluate the status of environmental education and public awareness along with their implications
19. **Keywords:**
20. Environmental monitoring, Management, Biomonitoring, Environmental audit, Environmental clearance, Environmental Impact Assessment, Environmental protection
21. **Unit I 6 lectures**
22. Concept and Approaches for environmental, monitoring and management
23. **Unit II: Air Quality, Water Quality and Solid Quality Monitoring 7 lectures**
24. Ambient and indoor air quality monitoring; Methods of collection and analyses of gaseous and particulate pollutants, air pollution standards.
25. **Unit III: 8 lectures**
26. Biomonitoring, Instrumentation
Passive and active biomonitoring, bioindication, bioindicator parameters; zonation study. Principles of chromatography, spectrophotometry, electro-analytical and radio-analytical techniques.
27. **Unit IV: 9 lectures**
Environmental Management System and Ethics
Environmental management system (EMS): ISO-14000; Environmental audit; Environmental clearance for establishing industries; Environmental Impact Assessment (EIA); EIA guidelines, Environmental taxes International trade and environment; Trade Related Intellectual Properties (TRIPs), Intellectual Property Rights (IPRs). Environmental education, public awareness, peoples participation in resource conservation and environmental protection
28. **Lab (BOUALG7)**
29. 1. Monitoring of dust capturing capacity of plants.
30. 2. Evaluation of visible injury symptoms of pollutants on plants.
31. 3. Monitoring of dust load at different sites.
32. 4. Rapid soil test for pH, alkalinity, nitrate, oxidizing potential.
33. 5. Rapid water quality test for temperature, pH, nitrate.
34. 6. Identification of water bloom forming micro-organisms.
35. 7. Visit to sophisticated environmental analysis lab.
36. 8. Field work for resource conservation and environmental protection.

Discipline Specific Elective I: Bioinformatics

Course code: BOUETD1

(Credits: Theory-4, Practical-2)



THEORY (Lectures: 60)

Learning outcomes:

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

Understand the concept of databases and use of different public domain for DNA and proteins sequence retrieval.

Understand the concept of pairwise alignment of DNA sequences using algorithms.

Explain the structure of proteins homology modeling approach using SWISS MODEL and SWISS-PDB.

Reflect upon the role of various models in molecular evolution.

Analyze the role of (QSAR) techniques in Drug Design.

Unit 1. Introduction to Bioinformatics (5 Lectures)

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2. Databases in Bioinformatics (5 Lectures)

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3. Biological Sequence Databases (25 Lectures)

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.

Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

Unit 4. Sequence Alignments (10 Lectures)

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5. Molecular Phylogeny (8 Lectures)

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.



**Unit 6. Applications of Bioinformatics
Lectures)**

(7

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

Lab (BOUELD1)

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Discipline Specific Elective II: Natural Resource Management

Course code: BOUETD2

(Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Learning outcomes:

At the end of the course the students will be able to,

Understand the concept of different natural resources and their utilization.

Critically analyze the sustainable utilization land, water, forest and energy resources.

Evaluate the management strategies of different natural resources.

Reflect upon the different national and international efforts in resource management and their conservation

Keywords:

Sustainability, EIA, GIS, Carbon Footprint, renewable energy, CBD, Nagoya Protocol

Unit 1: Natural resources:

Definition and types. **(2 lectures)**

Unit 2: Sustainable utilization:

Concept, approaches (economic, ecological and socio-cultural). **(8 lectures)**

Unit 3: Land **(8 lectures)**

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4: **(8 lectures)**

Water: Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 5: **(12 lectures)**



Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 6: (6 lectures)

Forests: Definition, Cover and its significance (with special reference to India); Major and minor forestproducts; Depletion; Management.

Unit 7: (6 lectures)Energy: Renewable and non-renewable sources of energy

Unit 8 (8 lectures)

Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Unit 9:

National and international efforts in resource management and conservation**(4 lectures)**

Lab (BOUELD2)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

Discipline Specific Elective IX: Horticultural Practices

Course code: BOUETD9

(Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Learning outcomes:

At the end of the course the students will be able to:

Understand the concept of different types of horticultural crops, their conservation and management

Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromatic plants.

Critically evaluate different cultivation practices and disease management

Reflect upon different Landscaping practices and garden design

Keywords:

IPR, Biofertilizers, Aromatic Plants, Japanese Gardens, Quarantine, Cultivars

Unit I: Horticultural Crops - Conservation and Management 12 lectures

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; urban horticulture



and ecotourism. Documentation and conservation of germplasm; Role of micro-propagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

Unit II: Ornamental Plants, Floriculture **12 lectures** Propagation of plants for beauty: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coral tree etc.- as are available in the area). Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions

Unit III: Plants for Nutrition and Health: Fruit and Vegetable Plants **11 lectures**
Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits). Production, origin and distribution; Description of plants and their economic products; Cultivation, processing and marketing of products of major medicinal plants (Mints, Ashwagandga, Amla, Saravar, Vetiver, Damask Rose, Aloe vera).

Unit IV: Medicinal and Aromatic Plants, Cultivation and Cultural Practices, Disease Management and Scaping and Garden Design **10 lectures**

Application of manure, organic, chemical and Biofertilizers, micronutrients; Weed control; biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations. Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices; Identification of common diseases and pests of ornamentals, fruits and vegetable crops. Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

Lab (BOUELD9)

1. Field trips: Field visit to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at agricultural institutes / universities or other suitable locations.
2. Identification of major conditions responsible for spoilage of horticultural crops.
3. Identification of pathogenic and non-pathogenic diseases of horticultural plants
4. More Practical may be added depending on the local habitats and available facilities

Skill Enhancement Course I: Biofertilizers

Course code: BOUDTL1

(Credits: Theory 2, Lab/ Training/ Field visit -2)



THEORY (Lectures: 30)

Learning outcomes:

On the completion of this course, the students will be able to;

Develop their understanding on the concept of bio-fertilizer

Identify the different forms of biofertilizers and their uses

Compose the Green manuring and organic fertilizers

Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers and vesicular arbuscular mycorrhizal (VAM).

Interpret and explain the components, patterns, and processes of bacteria for growth in crop production

Keywords:

Useful microbes, Cyanobacteria, Mycorrhiza, Organic farming, Recycling, Vermicompost

Unit 1:

General account about the microbes used as biofertilizer - Rhizobium - isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. **(4 lectures)**

Unit 2:

Azospirillum: isolation and mass multiplication - carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics crop response to *Azotobacter* inoculum, maintenance and mass multiplication. **(8 lectures)**

Unit 3:

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation. **(4 lectures)**

Unit 4:

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield - colonization of VAM - isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. **(8 lectures)**

Unit 5:

Organic farming - Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes - biocompost making methods, types and method of vermicomposting - field Application. **(6 lectures)**

Lab/ Training/Field visit (BOUCLL1)

Based on Theory paper



Skill Enhancement Course II: Herbal Technology

Course code: BOUDTL2

(Credits: Theory 2, Lab/Training/ Field visit -2)

THEORY (Lectures: 30)

Learning outcomes:

- On completion of this course the students will be able to;
- Develop their understanding on Herbal Technology
- Define and describe the principle of cultivation of herbal products.
- List the major herbs, their botanical name and chemical constituents.
- Evaluate the drug adulteration through the biological testing
- Formulate the value added processing / storage / quality control for the better use of herbal medicine
- Develop the skills for cultivation of plants and their value added processing / storage / quality control

Keywords:

Herbal medicines, Plant products, Biopesticides, Pharmacognosy, Adulteration, Secondary metabolites

Unit 1:Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage -marketing and utilization of medicinal plants.

(6 Lectures)

Unit 2: Pharmacognosy - systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

(6 Lectures)

Unit 3:Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster).

(6 Lectures)

Unit 4:Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation -Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)

(8 Lectures)

Unit 5:Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy)

(4 Lectures)

Lab/ Training/Field visit (BOUCLL2)



Based on Theory paper

Skill Enhancement Course III: Mushroom Culture Technology

Course code: BOUDTL3

(Credits: Theory 2, Lab/Training/ Field visit -2)

THEORY (Lectures: 30)

Learning outcomes:

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

Recall various types and categories of mushrooms.

Demonstrate various types of mushroom cultivating technologies.

Examine various types of food technologies associated with mushroom industry.

Value the economic factors associated with mushroom cultivation

Device new methods and strategies to contribute to mushroom production.

Keywords:

Edible mushrooms, Poisonous mushrooms, Cultivation technology, Mushroom bed, Mushroom unit, Storage and Nutrition

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

(5 Lectures)

Unit 2: Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production. **(12 Lectures)**

Unit 3: Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

(8 Lectures)

Unit 4: Food Preparation : Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

(5 lectures)

Lab/ Training/Field visit (BOUCLL3)

Based on Theory paper



Skill Enhancement Course IV: Nursery and Gardening

Course code: BOUDTL4

(Credits: Theory 2, Lab/Training/ Field visit -2)

THEORY (Lectures: 30)

Learning outcomes:

- On completion of this course the students will be able to;
- Understand the process of sowing seeds in nursery
- List the various resources required for the development of nursery
- Distinguish among the different forms of sowing and growing plants
- Analyse the process of Vegetative propagation
- Appreciate the diversity of plants and selection of gardening
- Examine the cultivation of different vegetables and growth of plants in nursery and gardening

Keywords:

Nursery, Gardening, Seed dormancy, Vegetative propagation, Seedlings, Landscape

Unit I

7 lectures

Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

Unit II

7 lectures

Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

Unit III

7 lectures

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glasshouse.

Unit IV

7 lectures

Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

Sowing/raising of seeds and seedlings: Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Lab/ Training/Field visit (BOUCLL4)

Based on Theory paper

Skill Enhancement Course V: Environmental impact analysis

Course code: BOUDTL5

(Credits: Theory 2, Lab/Training/ Field visit -2)



THEORY (Lectures: 30)

Learning outcomes:

After completing this course the learner will be able to;
Have critical understanding of environmental impact
Learn important steps of EIA process
Interpret the environmental appraisal and procedures in India.

Keywords:

Environmental management, Environmental impact assessment, Project proponent, Consultant, Environmental audit, Risk assessment, Legislation

Unit I: Origin and Development lectures 8

Purpose and aim, core values and principles, History of EIA development, Environmental Management Plan, Environmental Impact Statement, Scope of EIA in Project planning and Implementation.

Unit II: EIA Process lectures 8

Components of EIA, EIA Methodology- Screening, Scoping, Baseline data, Impact Identification, Prediction, Evaluation and Mitigation, Appendices and Forms of Application, Techniques of Assessment-Cost-benefit Analysis, Matrices, Checklist, Overlays, Impact on Environmental component: air, noise, water, land, biological, social and environmental factors. EIA Document.

Unit III: Main participants in EIA Process lectures 7

Project proponent, environmental consultant, PCBs, PCCs, public and IAA. Public participation.

Unit IV: Environmental Appraisal and Procedures in India and EIA 7 lectures

Methodology, indicators and mitigation, Environmental Audit of different environmental resources, Risk Analysis, Strategic environmental assessment, ecological impact assessment: legislation.

Lab/ Training/Field visit (BOUCLL5)

1. Prepare a Matrix of every environmental existing resource of your college or your hostel/mohalla or any defined area and evaluate each component using established methods and make audit analysis
2. Prepare a case report of Environmental impact of any area under development

Skill Enhancement Course VI: Agriculture and Food Microbiology

Course code: BOUDTL6

(Credits: Theory 2, Lab/Training/ Field visit -2)

THEORY (Lectures: 30)

Learning outcomes:



After completing this course the learner will be able to;

Develop understanding of the significance of intrinsic and extrinsic factors on growth of micro-organism

Identify ways to control microbial spoilage of foods

Analyze the practices involved in Food Microbiology

Keywords:

Symbiotic bacteria, Free living bacteria, Cyanobacteria, Biofertilizers, Food poisoning, Food intoxication, Fermented foods

Unit I: Role of Microorganisms in Agriculture

8 lectures

Role of symbiotic and free-living bacteria and cyanobacteria in agriculture., Mycorrhiza, Plant Growth Promoting Microorganisms (PGPM) and Phosphate Solubilizing Microorganisms (PSM).

Unit II: Biocontrol and Biofertilization

8 lectures

Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands, Biofertilizers: Types, technology for their production and application, vermi-compost.

Unit III: Food Microbiology-I

7 lectures

Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein.

Unit IV: Food Microbiology-II

7 lectures

Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food preservation processes. Microbes and fermented foods: Butter, cheese and bakery products.

Lab/ Training/Field visit (BOUCLL6)

Based on Theory paper

Skill Enhancement Course VII: Floriculture

Course code: BOUDTL7

(Credits: Theory 2, Lab/Training/ Field visit -2)

THEORY (Lectures: 30)

Learning outcomes:

After completing this course the learner will be able to;

Develop conceptual understanding of gardening from historical perspective

Analyze various nursery management practices with routine garden operations.

Distinguish among the various Ornamental Plants and their cultivation

Evaluate garden designs of different countries

Appraise the landscaping of public and commercial places for floriculture.

Diagnoses the various diseases and uses of pests for ornamental plants.



Keywords:

Gardening, Transplanting, Mulching, Plant growth regulators, Ornamental plants, Commercial floriculture

Unit I

8 lectures

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening. Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit II

8 lectures

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and fern allies; Cultivation of plants in pots; Indoor gardening; Bonsai. Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

Unit III: Landscaping

5 lectures

Places of Public Importance: Landscaping highways and Educational institutions

Unit IV

9 lectures

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Liliium, Orchids). Diseases and Pests of Ornamental Plants.

Lab/ Training/Field visit (BOUCLL7)

Based on Theory paper



M.Sc. Botany

Discipline Specific Elective 8: Agricultural Microbiology

Course code: BOPCTD8

(Credits: Theory-3, Practical-2)

Learning Outcomes:

To gain knowledge about fundamentals of Agriculture Microbiology.

To understand the concept of microbial interactions with plants and diseases caused by microbes.

To learn about Biopesticides, Bioherbicides and Biofertilizers.

To learn the scope and applications of Artificial intelligence and Machine learning in agricultural microbiology

To learn about role of earth worms-microbes interactions

Gain wide information about agricultural microbiology. K3

Able to formulate, produce and guide the usage of biopesticides, bioherbicides and biofertilizers to the needy farmers K6

Able to understand the scope and applications of AI & ML. K4

Able to start small scale industries on spirulina and mushroom cultivation.

Unit I: Basics of Soil Microbiology

Soil Microbiology-Structure, Types, Physical and Chemical properties-Soil microbes (Types and Enumeration)-Weathering and Humus formation, Soil pollution-Sources. Biogeochemical cycling Nitrogen, Carbon, Phosphorous, Sulphur, Iron cycles and its importance.

Unit II: Microbial Interactions

Microbial interaction-among microbes- Neutralism, Commensalism, Symbiosis, Synergism, Amensalism, Parasitism, Predation and Competition. With plants- Phyllosphere, Rhizosphere, Mycorrhizae - vesicular arbuscular mycorrhizae (VAM) - ecto, endo, ectendomycorrhizae . Symbiotic and free-living nitrogen fixers (Rhizobium, Azotobacter, Azospirillum, Frankia, BGA



and Azolla -Phosphate solubilizers (Phosphobacterium and Aspergillus) Interrelationships between soil microbes and plants, Rhizosphere concept, R:S ratio, rhizoplane; spermosphere; phyllosphere, Mycorrhizae-types, Rumen flora, Insects microbial interactions

Unit III: Phytopathology

Phytopathology – Classification of plant diseases, signs, and related terminology. Bacterial disease – Citrus canker, Blight of paddy, Fungal Disease- Red rot of sugarcane, Black stem rust of wheat, Tikka leaf spot, Wilt of cotton, Viral Disease – TMV, Vein clearing disease. Principles and methods of plant disease management, integrated plant disease management.

Unit IV: Biocontrol Agents and Symbiotic Microorganisms

Interaction of pesticides with soil microorganisms. Biopesticides- Bacillus thuringiensis, B. Sphaericus, B. Popilliae, Psuedomonassyringae. Microbial control of plant pathogens Trichoderma, Use of Baculovirus, NPV virus, Protozoa & Fungi in biological control. Microbial herbicides-Useful genes from microorganisms for agriculture (Herbicide resistant, Bt, Viral). Agricultural antibiotics.

Earthworms and microorganisms- The effects of earthworms on the number, biomass and activity of microorganisms, Role of Earth worms in organic agriculture. Production, formulation, packing and marketing of single cell proteins (mushrooms, spirullina and yeast); Biofertilizers Introduction, biofertilizers using nitrogen fixing microbes- phosphate solubilisation- *Rhizobium*, *Azospirillum*, *Azolla*; *Anabaena* symbiosis, Blue green algae and Ecto and Endomycorhizae. Cultivation, mass production and inoculation of *Rhizobium*, *Azobacter*, *Azospirillum*, *Azolla* and *Cyanobacteria*, Carrier- based inoculants, methods of application, quality control and agronomic importance. Application methods. Microorganisms for Bioassay and Biological warfare.

Unit V: AI in Agricultural Microbiology

Expert lectures, online seminars – webinars Scope of Artificial intelligence (AI) -Disease detection-health monitoring of crops. Applications of machine learning (ML)-prediction of microbial species-microbial communities to predict diseaseinteraction between microbes; Microbiome –disease association.

Lab (BOPDL08)

As per the syllabus topics



Discipline Specific Elective 2: Biofertilizer and Biopesticides Technology

Course code: BOPBTD2

(Credits: Theory-3, Practical-2)

Learning Outcome:

Syllabus focus on current needs of agriculture sector with respect to fertilizers.

Outcome : Will prepare students to understand the problems of farmers and tackle them with recent Biotechnological advances. Become skilled in Biofertilizer production.

Objectives : To enables students to understand the role of Biofertilizers in the field of agriculture and allied industry. Prerequisites : Technical understanding of microbial culturing, fermentation techniques is prerequisite to student to learn this syllabus.

UNIT I: Introduction to Biofertilizers

Introduction to Biopesticides Advantages of biofertilizers over chemical fertilizers General account of the microbes used as biofertilizers (any one) for various crop plants and their advantages over chemical fertilizers. Symbiotic N₂ fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants.

UNIT II: Biofertilizers and Biopesticides I

Types and application of Biofertilizers and Biopesticides Media composition and screening of superior strains Scale up of Inoculum. Mass scale production of Bio-inoculant Selection of carrier Factors affecting mass production of Bio-inoculant.

Unit III: Biofertilizers and Biopesticides II

Phosphate solubilizing microbes (any one) - Isolation, characterization, mass inoculum production, field Application.

Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

UNIT IV: Production methods



General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications. Curing of Inoculum and carrier mixture Norms for Packaging and Labelling of Bio-inoculant Efficacy study of developed inoculants, Importance of *Trichoderma* spp., *Pseudomonas* spp. and *Bacillus* spp. as a biocontrol agent. Mechanism of disease control by these organisms bioagents.

UNIT V: Strategies of marking

Strategies of marking, and Registration with CIB and organic farming institute. Importance of *Trichogramma*, *Cryptolaemus*, *Chrysoperla*, NPV and entomofungal pathogens. Quality parameters as per CIB specifications, Registration of biopesticides and case. Importance of *Verticillium/Beauveria/ Metarhizium/Nomuraea/ Paecilomyces/Hirsutella thompsoni* as biopesticides and their mass production.

Strategies of marking and Registration with CIB of bioagents and biopesticides

Lab (BOPCLD2)

1. Media used for biofertilizers, Biopesticides and bioagents production.
2. Isolation of *Rhizobium* from root nodules. Isolation of *Azotobacter*, *Acetobacter*, *Beijernickia*, *Azospirillum*. I. By dilution pour plate technique and II. By enrichment culture technique
3. Isolation of BGA, PSB, sulphur oxidizing microorganisms, ion chelator, potash mobilizers, organic matter decomposers I. By dilution pour plate technique and II. By enrichment culture technique
4. Estimating the efficiency of *Rhizobium* through pot culture experiments and through nodulation tests in test tubes and Leonard jar.
5. Production of *Rhizobium* commercial biofertilizers of *Azotobacter*, *Azospirillum*, *Acetobacter*, organic matter decomposers
6. Production of carrier biofertilizers of sulphur oxidizing microorganisms, ion chelator, potash mobilizers
7. Study of VA-mycorrhiza: growth on Guinea grass roots and observations for root colonization. Methods of preparation and application of VA-mycorrhizal inoculum
8. Mass production of *Trichogramma*, *Cryptolaemus*, *Crysoperla* (As per availability)
9. Mass production of HaNPV, SINPV and EPN (As per availability)
10. Mass production of *Verticillium/ Beauveria/ Metarhizium/ Nomuraea/ Paecilomyces/ Hirsutella thompsoni/ Trichoderma* (As per availability)



11. Mass multiplication of BGA and Azolla and its application in paddy field (As per availability)
12. Methods of application of biofertilizers, Biopesticides and bioagents
13. Quality control of biofertilizers: ISI standards specified and estimating the viable bacterial count in carrier based biofertilizers, Biopesticides and bioagents
14. Quality control tests for the biofertilizers, Biopesticides and bioagents
15. Preparation of plan of biofertilizers, Biopesticides and bioagents production unit and proposal of loan.
16. CIB Registration for Biopesticides and bioagents
17. Screening of superior strains using some in vitro techniques
18. Inoculum development
19. Check for cross contaminations
20. Large scale production of Bio-inoculant by using Lab fermenter
21. Preparation of carrier
22. Mixing of Inoculum and carrier
23. Effect of packaging on viability of inoculants
24. Study of shelf life of inoculant
25. Efficacy check of developed inoculant by using Pot experiment and its comparison with already available commercial Biofertilizers
26. Visits to Commercial biocontrol units and Krishi Seva Kendra



Discipline Specific Elective 4: Environmental Microbiology

Course code: BOPBTD4

(Credits: Theory-3, Practical-2)

Learning Outcomes:

The main objective is to understand the role of microbes in biogeochemical processes in different ecosystems.

To give information about various pollution sources and preventive measures to control pollution.

To learn in depth of various effluent treatments

Recognise and use the properties of microorganisms, principally bacteria, to remedy problems of contamination and other environmental impacts

Understand the various concepts of ecology

Aware of biogeochemical cycles - Carbon, Nitrogen, Phosphorus cycles etc. and microbes involved

Capable to assess the quality of water

Able to analyze solid waste management by various methods

Apply the various effluent treatment methods

Monitor the health status of ecosystems using AI

Unit I: Microorganisms and their Habitats

Structure and function of ecosystems-Terrestrial Environment: Soil profile and soil microflora
Aquatic Environment: Microflora of fresh water and marine habitats
Atmosphere: Aeromicroflora and dispersal of microbes
Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter

Unit II: Aerobiology



Microbial contamination of air-Sources of contamination-Biological indicators of air pollution. Enumeration of bacteria from air, Air sampling devices. Significance of air Microflora, Air sanitation. Air pollution : Types, source, method of sampling, measurement, impact on ecosystem and control. Control of noise and air pollution by biotechnological methods. Gaseous pollutants and odours: General sources, methods of control; fundamentals of adsorption, mechanism of adsorption.Application of adsorption for control of gaseous and odour emission. Noise pollution: Source, measurement, impact on ecosystem and control.

Unit III: Aquatic Microbiology

Microbiology of water (Aquatic environment-Fresh and Marine)-Water pollution: Impurities in water, water pollution by industrial waste, examination of water, collection of water samples, water analysis – physical, chemical and biological. Assessment of water quality (Chemical and Microbialindicator organisms) Water treatment processes: Primary treatment, screening, skimming with coagulants, flocculation, filtration, aeration and disinfection; Secondary treatment: Aerobic processes – activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactors; Tertiary treatment: Activated carbon treatment, reverse osmosis and electro dialysis. Water borne pathogens.

Unit IV: Solid Waste Management a

Sewage sludge treatment and utilization, refuse disposal, excreta disposal in unsewered area; composting and vermiculture.; bioconversion of cellulosic wastes into protein and fuel ;biodegradation of noncellulosic wastes for environmental conservation; bioaugmentation and biostimulation,; biodegradation of xenobiotics; bioremediation of contaminated soils and waste lands; radioactive product waste disposal.

Sources of pollution, impact on ecosystem and treatment of following industrial effluents: starch, paper and pulp, tannery, dairy, textile, distillery, oil refineries and pharmaceutical. Significance of ETP, STP, AHU, Bio inactivation plant. Microbes in mining, ore leaching, oil recovery, biopolymers, biosurfactants

Unit V: AI in Environmental Microbiology

Artificial Intelligence in monitoring the environment, species protection, saving energy and efficient agriculture. • Hsieh, William. (2009). Machine learning in the environmental sciences. Neural networks and kernels.

Expert lectures, online seminars – webinars •

Lab (BOPDL4)

As per the course



Discipline Specific Elective 5: Herbal Product Development and Formulation

Course code: BOPBTD5

(Credits: Theory-3, Practical-2)

Learning Outcomes:

To learn and understand the advances in the field of identification and isolation of drugs of herbal origin, various phytopharmaceuticals, nutraceuticals and their medicinal use and health benefits and to develop products based on herbs.

Upon completion of the course, the student shall be able to know the

Basics of the herbal based industry, its requirements and production of drugs.

Knowledge of various phyto-pharmaceuticals and their source, its utilization and medicinal value.

Various nutraceuticals/herbs and their health benefits.

Drugs of herbal origin.

Herbal pharmacovigilance.

Herbal product development

Unit-I : Introduction

Herbal Based industry: Scope, study of infrastructure, staff requirements, project profiles, equipments, processing, research and development & Regulatory requirements. Role of natural products in herbal medicines. General status and importance of herbal medicines. Safety of herbals/herbal pharmacovigilance.

Unit -II : Herbs as raw materials

Definition of herb, herbal medicines, herbal medicinal product and herbal drugpreparations. Source, selection, identification and authentication of herbal materials. Drying and processing of herbal raw materials. Packing and labelling of finished products.

Unit-III :Standaridization of herbal extracts



Physical, chemical, spectral and toxicological standardization, qualitative and quantitative estimations exemplified by the methods of preparation of at least two standardized extracts.

Stability studies for extracts. Predictable chemical and galenical changes

Unit-IV : Herbal Product Development

Preparation of liquid orals, tablets, capsules, ointments, creams and cosmetics.

Methods involved in monoherbal and polyherbal formulation with their merits and demerits.

Excipients used in herbal formulation, Compatibility studies, Stability studies Bioavailability & Pharmacokinetic aspects for herbal drugs.

Quality Control of finished herbal medicinal products.

Unit -V: Screening of natural products for the following biological activities

(a)Antidiabetic (b)Antifertility (c)Antihypertensive (d) Antiarrhythmics (e)Antipyretics (f)Antioxidants (g)Antibacterial (h)Antifungal (i)Antiepileptics (j)Osteoporosis (k) Nephroprotective (l)Immunomodulators and (m)Alzheimers etc.

Lab (BOPDL5)

As per the course



Discipline Specific Elective 11: Herbal Cosmetics

Course code: BOPCTD11

(Credits: Theory-3, Practical-2)

Learning Outcomes:

After undergoing this course students will be able to:

Explain the economic aspects of various herbal/natural cosmetic preparations

Describe the regulatory provisions and the principles of various herbal/natural cosmetic preparations

Analyse commonly used raw materials and design of herbal cosmetic formulations.

Develop the skill to formulate and evaluate herbal cosmetics

Apply the test methods in the analysis of cosmetics, as per Drug and Cosmetics Act and also toxicity screening methods.

Discuss the market potential of herbal cosmetics and various aspects including its raw materials, preparations and analysis.

This subject deals with the study of preparation and standardization of herbal/natural cosmetics. This subject gives emphasis to various national and international standards prescribed regarding herbal cosmeceuticals.

After completion of the course, student shall be able to

Understand the basic principles of various herbal/natural cosmetic preparations.

Current Good Manufacturing Practices of herbal/natural cosmetics as per the regulatory authorities.

Unit I: Introduction

Herbal/natural cosmetics, Classification & Economic aspects



Regulatory Provisions Relation to Manufacture of Cosmetics, License, GMP, offences & Penalties, Import & Export of Herbal/natural cosmetics, Industries involved in the production of Herbal/natural cosmetics

Unit II: Herbal cosmetics

Commonly used herbal cosmetics, raw materials, preservatives, surfactants, humectants, oils, colors, and some functional herbs

Pre-formulation studies, compatibility studies, possible interactions between chemicals and Herbs, Design of herbal cosmetic formulation

Unit III: Herbal Cosmetics science

Physiology and chemistry of skin and pigmentation, hairs, scalp, lips and nail, Cleansing cream, Lotions, Face powders, Face packs, Lipsticks, Bath products, soaps and baby product

Preparation and standardisation of the following: Tonic, Bleaches, Dentifrices and Mouth washes & Tooth Pastes, Cosmetics for Nails

Unit IV: Cosmeceuticals of Herbal and Natural Origin

Hair growth formulations, Shampoos, Conditioners, Colorants & hair oils, Fairness formulations, vanishing & foundation creams, anti-sun burn preparations, moisturizing creams, deodorants

Unit V: Analysis of Cosmetics

Analysis of Cosmetics, Toxicity Screening and Test Methods Quality control and toxicity studies as per Drug and Cosmetics Act

Lab (BOPDLD11)

As per the course



Discipline Specific Elective 12: Microbial Technology

Course code: BOPCTD12

(Credits: Theory-3, Practical-2)

Learning Outcomes:

The students will -

Be able to understand and appreciate role of microbes in their life.

Develop theoretical and technical skills of basic microbiology (sterilize, isolate, culture, preserve microbes).

Understand the physiological, biochemical and molecular mechanisms underlying the use of microbes in human welfare and environment.

Unit I: General Microbiology:

Diversity of the microbial world; Microbial nutrition, growth and metabolism

Unit II: Agricultural Microbiology:

Agriculturally important microorganisms; Biological nitrogen fixation; Mycorrhizae, microbial mineralization, Biocontrol of plant diseases, Plant growth promoting rhizobacteria (PGPR).

Unit III: Microbes and quality of environment:

Distribution and implications of microbes in air - bio-aerosols, microbial flora of water, water pollution, drinking water and domestic waste treatment systems; Microbial pesticides, microbial degradation of pesticides and toxic chemicals, biodegradation of the agricultural residues, bioremediation of contaminated soils. Microbes in nanotechnology, biosensors; Microbes in extreme environments.

Unit IV: Food and industrial microbiology:



Fermentation, fermented foods, fermenter design and growth processes, food spoilage, methods of food preservation; Microbes in recovery of metal (bioleaching) and oil, Cell and enzyme immobilization, microbial enzymes of industrial interest; Novel medicines from microbes.

Lab (BOPDLD12)

As per the course

Discipline Specific Elective 13: Plant Propagation and Nursery Development

Course code: BOPCTD13

(Credits: Theory-3, Practical-2)

Learning Outcome

Student can go for establishment of their own nursery where they can multiply the plants of their own interest as per demand.

The study will be helpful for propagation and care of varied valuable plant species such as ornamental, medicinal and other important plants.

To circulate technical knowledge related to plant propagation and for nursery development it will be beneficial.

Unit I: Plant nursery

What is and why need, Types, Significance, Basic Requirements to set up a Plant Nursery, Steps involved in its set up. Components for Nursery Development. Glass house and green house.

Unit II: Plant Propagules

Vegetative plant parts and Seeds, Modifications of plant parts - as a source of new plantlets, Biotic and abiotic agents and their role in plant development.

Unit III: Plant Propagation

Methods for Plant Propagation using by Vegetative/modified plant parts and by seeds, Budding, Layering, Cutting and Grafting and their significance of plant propagation.

Unit IV: Plant Tissue culture



Basics of tissue culture, Requirements, Precautions, Totipotency, Callus and Cell differentiation, Morphogenesis. Application of plant tissue culture in plant propagation and conservation. Hybrids and Cybrids, Artificial Seeds.

Unit V: Seeds as a source of new plantlets

Basic structure of flower, Steps involved in Seed development, Embryo sac and endosperm, Seed structure, diversity, types, dispersal and germination.

Lab (BOPDL13)

1. To Study Monocot and Dicot Seeds
2. To study structure of seeds
3. Experiment on Plant propagation using Stem/leaf cutting
4. Experiment on Budding in plants
5. Experiment on Layering in plants
6. Experiment on Grafting in plants
7. To study on variation in Seeds
8. To study on Seed dispersal
9. To study aerial plant parts modification
10. To study underground plant parts modification.



Discipline Specific Elective 16: Ethno-Pharmacognosy and Nutraceuticals

Course code: BOPDTD16

(Credits: Theory-3, Practical-2)

Learning outcomes

Knowledge of ethno traditional medicinal plants of India

Scope, medicinal value and standardization of nutraceuticals and regulatory aspect of nutraceuticals

Occurrence, isolation, characterization, identification, biosynthesis and activity profile of biologically active natural products.

Study for quality and safety monitoring of herbal drugs.

Unit I: Ethnobotany

Introduction, scope and relevance and interdisciplinary Science. The ethnobotanical data documentation; Traditional Botanical Knowledge (TBK), TKDL

Unit II: Nutraceuticals- Current trends and future scope

Inorganic mineral supplements, Vitamin supplements, Digestive enzymes, Dietary fibres, Cereals and grains, Health drinks of natural origin, Antioxidants, Polyunsaturated fatty acids, Herbs as functional foods, Formulation and standardization of nutraceuticals, Regulatory aspects, FSSAI guidelines. Sources, name of marker compounds and their chemical nature, medicinal uses and health benefits of following, Spirulina, Soya bean, Ginseng, Garlic, Broccoli, Green and Herbal Tea, Flax seeds, Turmeric and "Sattu".



Unit III: Phytopharmaceuticals

Occurrence, isolation and characteristic features (Chemical nature, uses in pharmacy, medicinal and health benefits) of following • Carotenoids – α and β – Carotene, Xanthophyll (Lutein) • Limonoids – d-Limonene, α – Terpineol • Saponins – Shatavarins • Flavonoids – Resveratrol, Rutin, Hesperidin, Naringin, Quercetin • Phenolic acids- Ellagic acid • Vitamins • Tocotrienols and Tocopherols • Andrographolide, Glycolipids, Gugulipids, Withanolides, Vascine, Taxol • Miscellaneous

Unit IV: Classification of crude drugs

Alphabetical, Taxonomical, Morphological, Clinical, Pharmacological and Chemotaxonomic. Study of crude drugs: Bark drug- *Cinchona*; Leaf drug- *Digitalis*; Flower drug: Clove; Seed drug: *Isaphaghula*; Fruit drug: Poppy; Rhizome and root drug: *Glycyrrhiza*, Unorganized drug: *Butea*; Gums: *Acacia*, Resin: *Ferula*; Fixed oil: *Ricinus*

Unit V: Methods of drug evaluation

Morphological, physical, chemical, biological, phytochemical investigations. Preliminary phytochemical tests for alkaloids, saponins, phenolic compounds, tannins, gums, mucilage, starch, carbohydrates and glycosides

Lab (BOPDL16)

1. Determination of Stomatal number index, Frequency and Pore Area and Organolaptic studies.
2. Documentation of traditional and local patterns of plant use and Submission of Reports.
3. Phytochemical tests for alkaloids, saponins, phenolic compounds, tannins, gums, mucilage, starch, carbohydrates and glycosides.
4. Demonstration of Phytochemical screening methods: Paper Chromatography, TLC, HPLC, Spectrophotometry etc.
5. Industry visit within and nearby areas,
6. Methods of extraction



Discipline Specific Elective 17: Food Microbiology

Course code: BOPDTD17

(Credits: Theory-3, Practical-2)

Learning Outcomes:

To impart knowledge about the various areas related to food science as a discipline

To encode the importance of the role of microorganisms in food industries both in beneficial and harmful ways

To develop an understanding of food composition, principles of preservation, new product development, food quality and analysis and food safety standard law.

Explain importance of different types of food in balanced diet and diet planning

Differentiate between different nutrient components in food and their role in processing and consumption

Determine food quality by food analysis as per food safety standard law and the their importance in food industry

Apply traditional methods for food preservation in developing a new food product.

Able to identify the characteristics of foodborne, waterborne and spoilage microorganisms

Unit I: Fermentation Products

Dairy products: - Production of starter cultures; Cheese - principles of cheese making. Cheddar Cheese, Swiss Cheese, Surface ripened Cheeses; Mold ripened Cheeses. General principles of



manufacture of Yogurt, acidophilus milk, Kefir, Koumiss. Fermented foods: Soy sauce, Miso, Sufu, Natto, Idli, fermented fish products. Fermented vegetables: Sauer kraut, pickles, Olives. Fermented sausages.

Unit II: Distilled beverages & Food additives

Alcohol, wine, brandy and beer. • Production of additives - organic acid (acetic acid, lactic acid and citric acid), amino acids (glutamic acid, lysine, threonine, arginine and histidine), food flavourants and pigments

Unit III: Food Spoilage and Public Health & Food Preservation

Staphylococcal, Salmonellosis, E.coli, Botulism, aflatoxin and amine production; food spoiling enzymes; Deterioration of foods- vegetables, meat, poultry, sea food and fruits, • Principles of food preservation - methods of preservation: Physical (irradiation, drying, heat processing, chilling and freezing, high pressure and modification of atmosphere); Chemical (Sodium benzoate Class I & II); Biological: Probiotics and bacteriocins.

Unit IV: Indicator Organisms

Direct examination - culture techniques - enumeration methods - plate - Viable & Total Count; Alternative methods - Dye reduction tests , electrical methods , ATP determination: Rapid methods, immunological methods - DNA / RNA methodology - Laboratory accreditation,

Unit V: Food Process Technology

Packaging and canning of foods - preparation for packaging, thermal processing of foods: Microwave heating, thermal inactivation of microorganisms, thermal process, and evaluations, freezing and thawing of foods. Food process operations: Evaporation - single and multi-effect evaporation, dehydration, psychometric charts, drying-tunnel, tray, spray, drum, freeze, distillation; food processing aid through biotechnology, Food sanitation: Good manufacturing practices - Hazard analysis, Critical control points, Personnel hygiene. Food safety regulation in India

Contemporary Issues

Expert lectures, online seminars - webinars

Machine learning in food industry <https://spd.group/machine-learning/machine-learning-and-ai-in-food-industry/>



Examples of AI application in food industry <https://foodindustryexecutive.com/2018/04/6-examples-of-artificial-intelligence-in-the-food-industry/>

AI in Food Processing – Use Cases and Applications That Matter <https://emerj.com/ai-sector-overviews/ai-in-food-processing/>

Application of Machine Learning in Microbiology

<https://www.frontiersin.org/articles/10.3389/fmicb.2019.00827/full>

Lab (BOPDL17)

As per the course

Open Elective 1: Bio-Business and Entrepreneurship

Course code: BOPDAT01

(Credits: Theory-3, Practical-2)

Learning Outcome

At the end of the course the student will be able to:

Develop own products for commercialization

Start own Business for sustainable development

Apply for project proposal

Plan a project with a work plan, budget and schedule

Understand the marketing, strategies, schemes, challenges and scope of bio-products

Know the importance of bioethics, biosafety and IPR

Course are completed with Expert lectures, online seminars, webinars etc

Unit I: Bio Enterpreunership:

Introduction to bio-business, from the Indian context, SWOT analysis of bio-business.

Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its barriers. Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Global bio business and industry future trends.



Module-2 ENTREPRENEURSHIP OPPORTUNITY IN AGRI BIOTECHNOLOGY 0 hours

Unit II: Entrepreneurship Opportunity In Agri Bio-Business :

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management

Unit III: Entrepreneurship Opportunity in Industrial Bio-Business

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Bio pesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics.

Unit IV: Project Management, Intellectual Property, Technology Management and Startup Schemes:

Building Bio business challenges in Indian context-biotech partners (BICEPS, BIRAC, DBT, Incubation centers. Etc.), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Startup schemes in Indian government, Business incubation support schemes, Successful start-ups-case study.

Unit V: Regulatory Affairs, Bioethics & Bio-Safety:

Regulatory affairs in Bio business-regulatory bodies and their regulations (ex.FDA, EU, DSIR, AYUSH, FSSAI etc.) Public education of the process of biotechnology involved in generating new forms of life for informed decision-making. Ethical concerns of biotechnology research and innovation-Interference with nature fear of unknown, unequal distribution of risks. Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards. Biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management.



Lab (BOPDL01)

As per the course



Open Elective 2: Ecosystem Services and Biodiversity

Course code: BOPDATO2

(Credits: Theory-3, Practical-2)

Learning outcomes:

The field of ecosystem services presents a major new organizing framework for conservation and natural resources management that is being applied in diverse places globally. Ecosystem services are the conditions and processes through which natural and managed ecosystems, and their constituent species, sustain and fulfill human life. These services range from the provision of food and clean drinking water to climate regulation and flood mitigation to recreational activities and spiritual fulfillment, and much more. While these services from nature underpin our lives, most have been undervalued historically in land use, economic, and policy decisions. In extreme cases, the value of ecosystem services is only recognized after they are lost.

In this course, we will examine the linked ecological, economic, and institutional challenges towards better characterizing the contribution of ecosystem services to human wellbeing, and the development of methodologies and institutions for integrating ecosystem services into decision making. We will critically examine how these approaches are being advanced through research and practice by pioneering efforts in the academic, public, private, and nonprofit sectors.

Develop depth of knowledge about the theoretical foundations of the field of ecosystem services by linking concepts from ecology, geography, economics, and social science (and other pertinent areas).

Examine monetary and non-monetary methods for “valuing” nature and critically assess their assumptions and utility.

Identify and use methodologies and tools to integrate ecosystem services into decision making in the public, private, and non-profit sectors.

Critically examine policy efforts to design effective payment for ecosystem services programs and other institutional approaches for restoring and protecting ecosystem services.

Identify key research-action areas and new frontiers of research-action in the field of ecosystem services.

Empower students to integrate ecosystem services into decision-making in leadership positions across the public, private, and non-profit sectors.

Strengthen student’s written and oral communication skills for engaging policymakers, communities, the general public, and other audiences



Unit I: Introduction to Ecosystem Services:

Definition and Key concept; classification; ecosystem functions and services. Ecological sustainability and impacts of human interventions on ecosystems caused by land use, climate change, pollution, hazardous chemicals, acidification, harvesting / exploitation and introduction of species and organisms.

Unit II: Biodiversity

The role of biodiversity in the provision of ecosystem services.

Unit III: Ecosystem services I

Valuing ecosystem services.

Unit IV: Ecosystem services II

Paying for ecosystem services.

Unit V: Ecosystem services III

Governing for ecosystem services

Lab (BOPDL02)

1. Identification and characterization of ecosystem services of a nearby forest/ grassland/ pond ecosystem.
2. To identify and characterize various drivers impacting ecosystem services in of an ecosystem.
3. To study the change in quantity and quality of ecosystem services due to varying degree of product extraction and other disturbances.
4. Quantification of various types of services as classified in the Millennium Assessment Goal of forest ecosystem
5. Field Trip :To understand use of ecology and conservation theory in informing habitat and species assessment, and their relevance to ecosystem services and biodiversity targets, current conservation management techniques, methods to assess and manage biodiversity, and data collection techniques and to determine the potential of the habitats on site to support notable and protected species.