COURSE OBJECTIVES AND OUTCOMES OF ¾ YEAR UNDERGRADUATES

CURRICULUM IN BOTANY

NISTARINI COLLEGE, PURULIA

AFFILIATED TO

SIDHO-KANHO-BIRSA UNIVERSITY

PURULIA, WEST BENGAL

BOTANY UG SYLLABUS FOR NEP 2020

SYLLABUS FOR BOTANY OF SEMESTER-1

SEMESTER: 1

Course Type: **MAJ-1**

Course Code: **BBOTMAJ01C**

Course Title: **Plants and Microbial Diversity and its Evolution**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Introduction to microbial diversity; Hierarchical organization and positions of microbes in the living world: Whittaker's five-kingdom system and Carl Richard Woese's three-domain system.	**3**
2	Viruses: characteristics; classification (Baltimore), idea about viroids and prions; detailed structure T4-phage and SARS-COV2, lytic and lysogenic cycle; Economic importance of viruses.	**7**
3	Bacteria general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Bergey's classification, Cell structure; Nutritional types; vegetative and Reproductive structure - asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).	**8**
4	Algae General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food, flagella; methods of reproduction; Classification; criteria, system of Fritsch, and idea of different groups as per Lee; Morphology and reproduction and life cycles of *Nostoc*, *Oedogonium*, *Chara*, *Fucus* and *Polysiphonia*. Diatoms and their importance. Idea about cultivation of *Spirulina;* Economic importance of algae in- Food and Nutraceuticals, Feed stocks, food colorants; fertilizers, aquaculture feed; therapeutics and cosmetics; medicines; dietary fibres from algae. Algal blooms and toxins.	**8**
5	Introduction to fungi, General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Heterothallism and parasexuality. Classification Ainsworth (up to Order). Life cycles of *Synchitrium*, *Saccharomyces*, *Ascobolus*, *Agaricus*. Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance. Application of fungi.	**8**

6	Introduction to Archegoniate, Unifying features of archegoniates, Alternation of generations. Bryophytes: General characteristics; Adaptations to land habit; Range of thallus organization. Idea about different orders. Morphology, anatomy and reproduction of *Marchantia, Porella, Anthoceros, and Funaria*; Ecological and economic importance of bryophytes with special reference to *Sphagnum*.	**7**
7	Pteridophytes: General characteristics; Idea about different orders. Morphology, anatomy and reproduction of *Psilotum, Selaginella, Equisetum* and *Adiantum. H*eterospory and seed habit. Ecological and economic importance.	**7**
8	Gymnosperms: General characteristics, idea about different orders, morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*; Affinities and evolutionary significance of Gymnosperms Ecological and economic importance.	**7**
9	Palaeobotany: Plant life through ages with evolutionary significane, Geological time scale, Early land plant *(Cooksonia*). Types of plant fossils - impressions, compressions, incrustation, actual remains petrifaction. Factors for fossilization, Radiocarbon dating. Importance.	**5**

Practical (Credits -2, 60 Hrs)

1. Electron micrographs/Models of viruses – T-Phage and Sars-CoV2, Sketches of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed in permanent slides/photographs. Micrographs of bacteria, binary fission, endospore, conjugation.
3. Study of curd organisms curd through Gram staining.
4. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium, Chara*, and *Polysiphonia*.
5. Study of *Ascobolus*, *Agaricus* and preparation of slides.
6. Study of *Saccharomyces* and *Penicillium* from permanent slides/photographs.
7. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through photographs. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
8. *Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
9. *Anthocero*s- Morphology of thallus, dissection of sporophyte (to show spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
10. *Funaria*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
11. *Psilotum*- Study of specimen, transverse section of synangium (permanent slide).
12. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
13. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores, transverse section of rhizome (all permanent slide).
14. *Adiantum*- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section

of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).

15. *Cycas*- Morphology (leaf), vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
16. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle (temporary slide), transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section &radial longitudinal sections stem (permanent slide).
17. *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (all permanent slide)
18. Study of fossil genera - *Rhynia, Cooksonia and Lepidodendron* through photographs.

Reading References:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.

2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.

4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International,New Delhi.

5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.

6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

7. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.

8. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.

9. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.

10. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

11. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

12. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.

13. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

14. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

COURSE OBJECTIVES:

I. After the completion of the course the students will be able to: 1. Develop understanding about the classification and diversity of Bacteria, viruses, Algae, Fungi & Lichens & their economic importance.
II. Develop conceptual skill about identifying microbes
III. To have the pleasure of the different antibiotics and their mode of action and harmful effects due to their careless uses in human life,
IV. The application of fungi in industry and agriculture with special reference to organic acid production, alcohol. Vitamins and the application of biofertilizers in the sustainable development has been focused.
V. The understanding of the cryptogams likes Bryophytes and Pteridophytes in plant world along with their diversity, classification and the contribution of different naturalists in this regard.
VI. The evolution of the land plants and the development of the vascular plants are the most thrust areas.
VII. The content also explores the morphological, anatomical and reproductive beauty of these life forms.
VIII. The content also addresses the different fossil life forms and the evolution of the diversity of life in the context of the geological time scale,
IX. The content also offers the exposure the application of these life forms for the human welfare.

Course Outcomes (C.Os):

I. To introduce the diversity of microbial, algal and cyanobacterial, fungal worlds, their identifying features, and applications; To know about the transition towards land habit, amphibians of the plant kingdom, pteridophytes and gymnosperms & their identification
II. Understanding the diversity of the biological world in general and virus, bacteria & algae of lower group of plant life forms in particular.
III. Understanding the growth and the beauty of reproduction.
IV. The application of the lower group of life forms in industry and growth of the economy of a country.
V. To know the different pharmaceutical products and other products derived from microbes.
VI. To understand the cryptogams in general and fungi in particular,
VII. Gather information regarding fungal diversity and their wide classification with species exposure,
VIII. Understand the different diseases associated with fungi and their impact in agriculture,
IX. Exposure of the concept of symbiosis along with the role of lichen and mycorrhizae in the environmental sustainability,

SEMESTER: 2

Course Type: **MAJ-2**

Course Code: **BBOTMAJ02C**

Course Title: **Cell Biology and Biochemical Basis of Life**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	**The Cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).	**2**
2	**Cell wall and plasma membrane:** Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. Exracellular matrix.	**5**
3	**Cell organelles:** Nucleus, Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semi-autonomous nature of mitochondria and chloroplast. Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes.	**15**
4	**Cellular communication:** General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.	**4**
5	**Cell division**: Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.	**4**
6	**Biomolecules:** Types and significance of chemical bonds; Structure and properties of water; pH and buffers. **Carbohydrates:** Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of	**20**

	biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non- reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. **Lipids:** Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides. **Amino acids:** Definition, classification & structures. Physico-chemical properties of amino acids (amphoteric molecules, ionisation, zwitterions, pk values, isoelectric point, Lambert-Beer's law, optical density, absorption spectra). **Proteins:** Primary, secondary, tertiary and quaternary structure (definition and example), structure of globular protein (albumin, globulin, haemoglobin & myoglobin – Structure, function and occurrence in brief) and fibrous protein (keratin, collagen -role of Vitamin C in hydroxylation, Structure, function and occurrence in brief), Forces that stabilize structure of proteins, salting in and salting out, absorbance of proteins **Nucleic acids:** Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on nucleic acids. Other functions of nucleotides – source of energy, component of coenzymes.	
7	**Bioenergenetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.	**5**
8	**Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; different classes of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.	**5**

Practical (Credits -2, 60 Hrs)

1. Measurement of plant cell size by the technique of micrometry.
2. Study of plant cell structure with the help of epidermal peel mount of *Onion/Rhoeo.*
3. Study the phenomenon of plasmolysis and deplasmolysis.
4. Study of cell and its organelles with the help of electron micrographs.
5. Study different stages of mitosis (onion root tip).
6. Preparation of normal, molar solutions and percent solutions (using NaCl and Sucrose).
7. Concept of pH and preparation of phosphate buffer.

8. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins (quantitative, standard curve, through Lowry method).
9. Estimation of DNA by diphenylamine method.
10. Estimation of RNA by orcinol method.

Reading References:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Course objectives :

I. After the completion of the course the students will be able to:
II. Develop comprehensive understanding about the cellular architecture, communication systems and divisional types.
III. Understand details about bio-molecules, enzymes and bioenergetics**.**
IV. To know the dynamic system of cell and equilibrium, with respect to the import and export of the different molecules across the different boundaries either active or passive mode in this regard along with the issues and problems.
V. To know the structural and functional aspect of cell at the ultramicroscopic level.
VI. To have the wide exposure of the Cell, division, growth with respect of the different cell division pattern along with the emergent anomalies derived due to the functional abnormalities of the cell in the eukaryotic world.

Course Outcomes (C.Os):

2.1.To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, organelles, enzymes and bioenergetics.

2,2.To understand the chemical nature of biological macromolecules, their th

2.3.To understand the basic chemistry in the exposure of the beauty of life

2.4.To know the application of enzymes, enzymetics and the mode of the action of enzymes in the welfare of the living world,

2.5.To have a brief and precise knowledge of bioenergetics, the principle of energy production in the biological world and the application of thermodynamics in the energy kinetics in the living world

2.6.The exposure of the different micro molecules, macromolecules and supra molecules like DNA, Protein , polysaccharides, Fats and their significance in the biological world

SEMESTER: 3

Course Type: **MAJ-3**

Course Code: **BBOTMAJ03C**

Course Title: **Morphology, Anatomy and Plant Taxonomy**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Vegetative morphology- A general account of root, stem & leaves with different types of modifications; Different types of stipules and modifications along with phyllotaxy and diversity of leaves.	**5**
2	Flower- different types of inflorescences**;** Floral morphology with special reference to adhesion and cohesion of the floral parts, Placentaion - types; Floral formula, Floral diagram.	**4**
3	Fruit s & seeds- types and their taxonomic relevance	**4**
4	Structure and Development of Plant Body internal organization of plant body: The three tissue systems, types of cells and tissues. Root stem transition. Apical meristems Evolution of concept of organization of shoot apex Types of vascular bundles; Structure of dicot and monocot stem.	**5**
5	Vascular Cambium and Wood Structure, function and seasonal activity of cambium; Secondary growth in root and stem with Types of Anomalous secondary growth with special emphasis on *Boerhavia and Dracaena*. Axially and radially oriented elements; reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.	**5**
6	Significance of Plant systematics as a synthetic science, Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.	**8**
7	Taxonomic hierarchy, Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature, Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.	**8**
8	Systems of classification, Idea on classification systems of	**8**

	Bentham and Hooker, Engler and Prantl and Takhtajan; Classification system of Bentham and Hooker (up to series). Brief reference of Angiosperm Phylogeny Group (APG IV) classification.	
9	Biometrics, numerical taxonomy and cladistics Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).	**5**
10	Phylogeny of Angiosperms Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram only).	**8**

Practical (Credits -2, 60 Hrs)

1. Study of phyllotaxy and stipules (including modifications).

2. Study of Inflorescence types- Racemose, Cymose, Special types and with respect to the specific families below

3. Study of floral morphology with special reference to adhesion and cohesion of the floral parts, placentation.

4. Study of different fruit types with respect to the specific families below

5. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):
Malvaceae – *Sida* sp. / *Abutilon* sp.
Acanthaceae – *Ruellia* sp./*Barleria* sp.
Fabaceae – *Tephrosia* sp./*Crotalaria* sp.
Verbenaceae – *Lantana* sp./*Duranta* sp.
Asteraceae - *Vernonia* sp./*Ageratum* sp., *Eclipta* sp./*Tridax* sp.
Solanaceae – *Solanum* sp./*Nicotiana* sp.
Lamiaceae – *Leucas* sp./*Ocimum* sp.
Euphorbiaceae – *Euphorbia* sp. / *Jatropha* sp.
Poaceae – *Triticum* sp./*Chrysopogon* sp. or any local common grass

Orchidaceae- *Vanda* sp.
6. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book – At least 25 nos.).

7. Root: monocot, dicot, secondary growth.
8. Stem: monocot, dicot - primary and secondary growth

9. Anatomy of Leaf: isobilateral, dorsiventral

10. Anomalous secondary growth (Through permanent slides).

11. Study of Stomata and its types

13. Field visit (two) at least one to study the local flora

Reading References:

1. College Botany: Volume 1 by Hirendra Chandra Gangulee (Author), Kumud Shankar Das (Author), Chittatosh Dutta (Author), Shyamapada Sen (Editor)
2. A Textbook of Botany: Vol II by Bhattacharya Ghosh Hait
3. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
4. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
5. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
7. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi.3rd edition.
8. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
9. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
10. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.
11. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

Course Objectives :

I. Students will learn the morphological, anatomical & systematic pleasure of the angiosperms world.
II. A detail concept & knowledge will develop to understand the angiosperm diversity.
III. The plant taxonomy & Systematic offers a reasoning knowledge for the assessment of the plant to explore the angiosperm world.
IV. It gives the flavor of the synthetic sciences by the taking the evidences of the different branches of plant sciences,
V. The Programme offers a wide knowledge in the field of the plant repository both actual and virtual in herbarium and botanical garden along with their significance and importance in plant identification and conservation.
VI. To address the different type of plant classification starting from Linnaeus to APG IV system to touch the different milestones in this field.
VII. Numerical taxonomy, Molecular Taxonomy & Biosystematics is the call of the time and these have widely explored along with the flavor of phylogeny in the context of Cladistics and Phenetics.
VIII. The plant Phylogeny is the most interesting episode in plant Biology and this issue has been widely explored with the help of different theories as far as origin of angiosperms.
IX. Last but not least, both the virtual and practical approach has been assigned sitting in the college premises to know about the global overview of the plant life.

Course Outcomes (C.Os):

3.1. This paper intends to offer the bird's eye view about the morphological, anatomical and systematic beauty of the angiosperms.

3.2. It offers the sound idea about the diversity of angiosperms along with its identification**.**

3.3. Understand the importance of plant morphology in allied branches of botany i.e. application of morphology in plant identification, classification and nomenclature.

3.4. Students get an idea about various floral whorl and its importance in plant reproduction.

3.5.To introduce the basic anatomy of the plant along with the role of the different anatomists both India and across the globe to enrich the domain.

3.6. To have the application of anatomical knowledge in other sciences like Plant Systematics and Pharmacognosy for solving the issues and challenges,

3.7. To introduce the idea of the developmental biology of the organization of the different level of the organization of the plant life.

3.8.To explore the wide diversity of plant tissues and the systems and their organizational beauty in the light of modification and specialization of the plant metabolites,

3.9. To introduce the Root-Stem transition along with the different theories related to the apex of the root and shoot.

3.10.To introduce the idea of the primary, secondary and the anomalous structure of the root and stem along with their degree of specialization in this regard taking a number of examples.

SEMESTER: 4

Course Type: **MAJ-4**

Course Code: **BBOTMAJ04C**

Course Title: **Molecular Biology, Genetics and Plant Breeding**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Nucleic acids: DNA as the carrier of genetic information (Griffith's, Hershey & Chase, McLeod & McCarty experiment).	**2**
2	The Structures of DNA and RNA/Genetic Material: DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure. Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome. Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.	**4**
3	The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; rolling circle and θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.	**5**
4	Transcription: Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: lac operon Eukaryotes: transcription factors, heat shock proteins, Gene silencing.	**4**
5	Processing and modification of RNA: Split genes-concept of introns and exons, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing, eukaryotic mRNA processing (5' cap, 3' poly A tail); Ribozymes; RNA editing.	**3**
6	Central dogma and genetic code: Genetic code (deciphering & salient features).	**2**
7	Translation: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and	**4**

	termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis.	
8	Mendelian genetics and its extension: Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Polygenic inheritance.	**5**
9	Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium.	**3**
10	Linkage, crossing over and chromosome mapping: Linkage and crossing over-Cytological and molecular basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping.	**3**
11	Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.	**3**
12	Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, and intercalating agents); Role of Transposons in mutation.DNA repair mechanisms.	**3**
13	Fine structure of gene: Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.	**3**
14	Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.	**4**
15	Plant Breeding: Introduction and objectives. Modes of reproduction in crop plants. Methods of crop improvement: Acclimatization; Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations. Role of mutations; Polyploidy; Distant hybridization; Heterosis: Theories and Applications.	**12**

Practical (Credits -2, 60 Hrs)

1. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
2. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
3. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments).
4. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

5. Isolation of genomic DNA from plant sample (demonstration through youtube video).
6. Meiosis through temporary squash preparation with special reference to *Allium sp*.
7. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
8. Chromosome mapping using point test cross data.
9. Idea about pre-treatment, fixation, staining and smear preparation.
10. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
11. Photograhs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

Reading References:

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjaminn Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

6. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.

7. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.

8. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
9. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

10. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
11. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH.2nd edition.
12. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

COURSE OBJECTIVES:

I. Another interesting topic is the genetic code and this topic easily can draw the attention for its beauty and the appetite of knowledge must be progressively increased after having the exposure of this curriculum
II. Transcription, modification, translation and processing of the non-genetic RNA are some of the most interesting topics and these can easily draw the attention of the biology students for its novelty.
III. To introduce the most interesting experiment both in hand and virtual are the outcomes of this course content.

Course Outcomes (C.Os):

IV. Understanding the mechanism and concepts of life process at molecular level.
V. Knowledge about nucleic acids, DNA organization, DNA replication, genetic code and transcription and translation.
VI. To understand the processing and modification of RNA
VII. To introduce the in-depth concept of helix of life, Nucleic acid and its different attributes in the design and the development of the plant world.
VIII. The historical perspective of DNA along with the some breakthrough experiments has been offered by this course,
IX. The structural organizations of the chromosome along with the different aspects are the pleasure of this course.
X. The replication of DNA and its different models along with the other attributes cal easily draw the attention of the innovation and experimental approach in this regard.

Course Type: **MAJ-5**

Course Code: **BBOTMAJ05C**

Course Title: **Economic Botany, Pharmacognosy and Natural Resource Management**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Natural resources Definition and types	**2**
2	Sustainable utilization Concept approaches (economic, ecological and socio-cultural).	**2**
3	Land Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.	**4**
4	Water Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.	**6**
5	Biological Resources Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).	**6**
6	Energy Renewable and non-renewable sources of energy.	**2**
7	Contemporary practices in resource management EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.	**4**
8	National and international efforts in resource management and conservation.	**2**
9	Origin of cultivated plants: Concepts of centres of origin and their importance with reference to Vavilov's work with special reference	**4**

	to Rice, Legumes and Beverages.	
10	Study of the following economically important plants (Scientific names, families, parts used and importance Spices, Ginger, cumin, Beverages- Tea, coffee, Medicinal plants-, neem, Vasaka, Vegetables- Potato, radish, bottle, Fibre yielding plants- jute, Timber yielding plants- Sal, Lac Culture, Fruits- Mango, Sugar yielding plant- Sugarcane.	**8**
11	Sources of oils and fats General description, classification, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, comparison with fatty oils & their uses.	**5**
12	Medicinal botany: History, scope and importance of medicinal plant, a brief idea about indigenous medicinal sciences- ayurveda, siddha and unani. Polyherbal formulations.	**3**
13	Pharmacognosy- General account: Pharmacognosy and its importance in modern medicine, Crude drugs, Classification of drugs- chemical and pharmacological, Drug evaluation– organoleptic, microscopic, chemical, physical and biological, Major pharmacological groups of plant drugs and their uses.	**5**
14	Secondary metabolites: 3.1 Definition of secondary metabolites and difference with primary metabolites, 3.2 Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only), 3.3 Major types–terpenoids, phenolics, flavonoids, alkaloids and their protective action against pathogenic microbes and herbivores.	**4**
15	Pharmacologically active constituents: Source plants (one example) parts used and uses of: 1 Steroids (Solasodin, Diosgenin, Digitoxin), Tannin (Catechin), Resins (Gingerol, Curcuminoids), Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine), Phenols (Sennocide and Capsaicin).	**3**

Practical (Credits -2, 60 Hrs)

1. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) and its impact on land degradation.

2. Estimation of foliar dust deposition.

3. Determination of total solid in water (TDS)

4. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)

5. Estimation of organic carbon percentage present in soil sample.

6. Collection of data on forest cover of specific area

7. Study of economically important plants (rice/jute/ tea) through herbarium specimens and field study. 2. Study of cultivation practices in field and submission of report.

8. Study of local economically important plants and submission of report with photographs

9. Chemical tests for (a) Tannin (Camellia sinensis / Terminalia chebula), (b) Alkaloid (*Catharanthus roseus*)

10. Powder microscopy – *Zingiber* and *Holarrhena*.

11. Histochemical tests of (a) Curcumin (*Curcuma longa*), (b) Starch in non-lignified vessel (*Zingiber*), (c) Alkaloid (stem of *Catharanthus* and bark of *Holarrhena*).

Reading References:

Economic Botany:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

Pharmacognosy:

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.

2. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.

3. Pharmacognosy, Dr. C. K. Kokate et al. 1999. Nirali Prakashan.

4. Trease and Evans' Pharmacognosy (27 May, 2009) by FRPharmS Evans, William Charles, BPharm, BSc, PhD, DSc, FIBiol, FLS (Author)

Natural Resource Management:

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.

2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Course Outcomes (C.Os):

I. To create an interest about the natural resources and its management practices among the students.
II. To create awareness about the economic important plants and their diverse uses in the society.
III. The content intends to offer a great deal of the information of the origin of the cultivated plants along with their method of the domestication in the evolution of the human civilization,
IV. The classification of the economic important plants is one of the thrust area in this regard,
V. The course also offers the art and the science of the cultivation of the different type of plants of cereals, pulses, vegetables, fruits, fibers a, beverages and other economic important plants.
VI. The course offers a value based knowledge of the different medicinal plants, their bioactive compounds, parts used along with their uses in the treatment of the different diseases./
VII. The course also offers a a very deep insight of the importance of the plants in the welfare of human along with the role of agriculture based industries to meet up the needs of the human and to cater the wheels of progress of human civilization.

Programme Outcomes (P.Os):

I. The students should able to identify the major economically important plants and their role in civilization.
II. Able to use evidenced-based comparative knowledge and the propagation of plants with respect to environmental conditions.
III. Students will able to understand the concept of biodiversity and conservation strategies
IV. To exploration of the scientific temperament for the judicious uses of natural resources for the sustainable development.
V. Develop an appreciation for the ecological diversity.
VI. Understand the historical importance of natural resources in the economic development.
VII. Understand the impact of changes in lifestyles and the implications for land management.

SEMESTER: 5

Course Type: **MAJ-6**

Course Code: **BBOTMAJ06C**

Course Title: **Ecology, Phytogeography and Sustainable Biology**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Introduction: Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.	**4**
2	Edaphic factors: Soil Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development; Water ; States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.: Light, temperature, wind and fire.	**8**
3	Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.	**6**
4	Population ecology: Characteristics and Dynamics, Ecological Speciation	**4**
5	Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.	**6**
6	Biotic interactions: Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism;	**4**

	food chains and webs; ecological pyramids; biomass, standing crop.	
7	Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.	**6**
8	Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.	**6**
9	Sustainable Biology- Definitions, Scope and its different attributes; principles of Sustainability: Scope of sustainability; Need of Sustainability in agriculture, Environment & man made different ecosystems.	**6**
10	Carrying capacity, Sustainable development and Environmental impact assessment. Earth summits, SDGs 17; Different environmental movement like Chipco, Silent valley; Different conferences for sustainable development and the conservation of biotic resources; Laws & regulations	**6**
11	Sustainability, global environmental challenges with special references to global warming & vulnerable ecosystems in Purulia.	**4**

Practical (Credits -2, 60 Hrs)

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each). (b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Field visit to familiarise students with ecology & Sustainability of different sites.

Reading References:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems

Approach.Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Course Outcomes (C.Os):

I. The students will have the pleasure of the cognitive development and get the latest exposure in the domain of plant sciences.
II. To mould a responsible citizen who is aware of the most basic domain-independent knowledge including the critical thinking
III. It introduces the level of the organizational aspect along with the different structural and functional attributes of the ecosystem.
IV. The dynamism & the homeostasis are two interesting part have explored widely.
V. the soil, water, light, wind, temperature and other abiotic factors have been widely covered along with their structural, functional and role of the designing of the environment are some of the outcomes of this course.
VI. Ecosystem, Population ecology & community ecology have been widely explained to give a wide knowledge in this domain.
VII. Biotic interactions and the functional issues of the ecosystem have been nicely addressed by the course and this can enough to create an interest among the students to interpret environment in the light of statics and computation.
VIII. Phytogeoigraphy, the different phytogeographical zones along with the distribution of the different plants across India has also been highlighted and this symbiosis of knowledge between geography & botany can open an avenue of thought in the interdisciplinary approach and the scientific inquisitiveness.
IX. Understand the definitions, scope, and principles of sustainability. Students will explore the importance of sustainability in agriculture, environment, and ecosystems, as well as its application in maintaining ecological balance.
X. Gain an understanding of carrying capacity, sustainable development, and the importance of environmental impact assessments. Students will examine various global sustainability movements, international summits, and laws/regulations related to environmental conservation.
XI. Understand the global environmental challenges, with a special focus on global warming and vulnerable ecosystems, particularly in Purulia. Students will be able to assess environmental challenges and understand the necessary steps towards global sustainability

Programme Outcomes (P.Os):

I. A knowhow for the development of the proper description of the different environmental issues,
II. Internalization of the concept of conservation and evolution through the channel of the spirit of enquiry.
III. The graduates should be knowledgeable and
IV. Plant water relations along with the different physiological processes like transpiration, guttation, ascent of sap and their effects on plants have been explored.
V. Mineral nutrition, mineral uptake along with the different other aspects like active& passive uptake and other related issues have been done as course outcomes.
VI. Transport across the phloem of the plant sap and the different models have been widely explored.
VII. The plant hormones are the most interesting topic. The different plant hormones along with their application in agriculture have been covered as course outcomes in this course.
VIII. Phytochrome, Phtoperiodism & vernalizations are explained in detail; so as to the students develop interest in this course as a part of innovative approach to study the subject.
IX. To introduce the different metabolic pathways and the integration and the regulation of the pathways along with the mechanisms in detail for the sake and survival of plants.

MAJOR–6

COURSETITLE-ECOLOGY,PHYTOGEOGRAPHYANDSUSTAINABLEBIOLOGY COURSE CODE:

BBOTMAJ06C

CREDIT:6(THEORY:4+PRACTICAL:2)

THEORY

1. **Introduction:** Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. **(4L)**
2. **Edaphic factors:** Soil Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development; Water ; States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.: Light, temperature, wind and fire. **(8L)**
3. **Ecosystems:** Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. **(6L)**
4. **Populationecology:**CharacteristicsandDynamics,EcologicalSpeciation.**(4L)**
5. **Plant communities**: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. **(6L)**
6. **Biotic interactions:** Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism, ; food chains and webs; ecological pyramids; biomass, standing crop. **(4L)**
7. **Functional aspects of ecosystem:** Principlesand modelsofenergyflow; Productionand productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus. **(6L)**
8. **Phytogeography:** Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation. **(6L)**
9. **Sustainable Biology-** Definitions, Scope and its different attributes; principles of Sustainability: Scope of sustainability; Need of Sustainability in agriculture,Environment & man made different ecosystems. **(6L)**
10. Carryingcapacity,SustainabledevelopmentandEnvironmentalimpactassessment.Earth summits, SDGs 17; Different environmental movement like Chipco, Silent valley;

Different conferences for sustainable development and the conservation of biotic resources; Laws & regulations. **(6L)**

11. Sustainability, global environmental challenges with special references to globalwarming & vulnerable ecosystems in Purulia. **(4L)**

PRACTICALS:

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximumandminimumthermometer,anemometer,psychrometer/hygrometer,rain gauge and lux meter.

2. DeterminationofpHofvarioussoilandwatersamples(pHmeter,universal indicator/Lovibond comparator and pH paper)
3. Analysisforcarbonates,chlorides,nitrates,sulphates,organicmatterandbasedeficiency from two soil samples by rapid field tests.
4. Comparisonofbulkdensity,porosityandrateofinfiltrationofwaterinsoilsofthree habitats.
5. Determinationofdissolvedoxygenofwatersamplesfrompollutedandunpolluted sources.
6. (a).Studyofmorphologicaladaptationsofhydrophytesandxerophytes(foureach). (b).Studyofbioticinteractionsofthefollowing:Stemparasite(*Cuscuta*),Rootparasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
7. Determinationofminimalquadratsizeforthestudyofherbaceousvegetationinthe college campus,byspeciesareacurvemethod(speciestobelisted).
8. Quantitativeanalysisofherbaceousvegetationinthecollegecampusforfrequencyand comparison with Raunkiaer's frequency distribution law.
9. Fieldvisittofamiliarisestudentswithecology&Sustainabilityofdifferentsites.

READINGREFERENCES:

1. Odum,E.P.(2005).Fundamentalsofecology.CengageLearningIndiaPvt.Ltd.,New Delhi. 5th edition.
2. Singh,J.S.,Singh,S.P.,Gupta,S.(2006).EcologyEnvironmentandResource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma,P.D.(2010).EcologyandEnvironment.RastogiPublications,Meerut,India.8th edition.
4. Wilkinson,D.M.(2007).FundamentalProcessesinEcology:AnEarthSystems Approach.Oxford University Press. U.S.A.
5. Kormondy,E.J.(1996).Conceptsofecology.PHILearningPvt.Ltd.,Delhi,India.4th edition.

COUSRSE OUTCOMEs (C.Os)

I. Understand the basic concepts of ecology and the different levels of biological organization, and recognize the interrelationships between living organisms and the environment. Students will also grasp the concept of homeostasis and its role in maintaining environmental balance.

II. Comprehend the significance of soil in the environment, including its formation, components, and profile. Understand the role of climatic factors in soil development and how water, temperature, light, and other physical factors influence the ecosystem.

III. Learn the structure and functioning of ecosystems, including trophic organization, food chains, food webs, and ecological pyramids. Students will develop a clear understanding of the processes that drive ecosystem functioning.

IV. Understand the characteristics and dynamics of populations, including geological speciation. Students will learn how populations evolve in response to environmental pressures and interactions with other species.

V. Grasp the concept of ecological amplitude, habitat, and niche, and understand the dynamics of plant communities, including succession, climax concepts, and the impact of ecological factors on community structure.

VI. Gain insight into the nature of biotic interactions such as symbiosis, parasitism, and commensalism. Students will also understand how these interactions contribute to energy flow and trophic dynamics in ecosystems.

Course Type: **MAJ-7**

Semester: **5**

Course Code: **BBOTMAJ07C**

Course Title: **Plant Physiology and Metabolism**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Plant-water relations: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.	**5**
2	Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents. Transport of ions across cell membrane.	**5**
3	Translocation in the phloem: Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.	**4**
4	Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid and Ethylene,	**5**
6	Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far-red light responses, Vernalization.	**4**
7	Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, and Isozymes).	**3**
8	Photosynthesis: photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2	**9**

	reduction, photorespiration, C4 pathways; CAM; Factors affecting CO_2 reduction.	
9	Respiration: Glycolysis, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, cyanide-resistant respiration, factors affecting respiration.	**8**
10	ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, role of uncouplers.	**4`**
11	Lipid metabolism: Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination.	**4**
12	Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.	**4**
13	Signal transduction**:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, Calcium calmodulin, MAP kinase cascade.	**5**

Practical (Credits -2, 60 Hrs)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To study the phenomenon of seed germination (effect of light).

6. Experimental demonstration of Hill's reaction.
7. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.

8. To compare the rate of respiration in different parts of a plant.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/Avena coleptile bioassay (demonstration).

4. Effect of auxins on rooting.
5. R.Q.

Reading References:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.

2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

4. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

Course Outcomes (C.Os):

I. Understand the role of physiological and metabolic processes for plant growth and development. Recognizing the wonderful mechanism of transport and the Interrelationships existing between metabolic pathways thereby gaining and idea about the importance of

II. After the completion of the course the students will be able to understand basic functions and intermediary metabolism in a plant body.

III. Gain knowledge on the role of physiological and metabolic processes for plant growth and development.

SEMESTER: 6

Course Type: **MAJ-9**

Course Code: **BBOTMAJ09C**

Course Title: **Plant Health Science and Technology**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Introduction to Plant Health Science–Definition and Importance of plant health science; Factors affecting plant health – edaphic factors and biotic factors; Basic principles of plant pathology, entomology and nematology; Plant health in response to plant stress physiology	**8**
2	Plant Pathogens and Diseases - Types of plant pathogens (viruses, bacteria, fungi, nematodes); Life cycle of pathogens; Mode of transmission; Plant-pathogen interactions- pathogenicity factors; Phytoalexins in defence mechanism; Systemic and Local acquired resistance; Common plant diseases and their symptoms- Late blight of potato, Black stem rust of wheat, Stem rot of jute, Brown spot of rice; Epidemiology of plant diseases; Disease development and progression; Symptomology; Symptoms variability; Disease diagnosis methods for biotic factors (visual, laboratory tests- PCR, ELISA, BIOLOG test) and abiotic factors; Impact of disease on plant growth and yield.	**15**
3	Plant Disease and Health Management - Principles of integrated pest management; Cultural practices of disease prevention, biological and chemical control methods; Resistance breeding; Soil fertility management; Weed management.	**8**
4	Plant Health in Agriculture–Disease management in agricultural system; Role of plant health in sustainable agriculture; Food safety and plant health.	**5**
5	Plant Health and the Environment–Impacts of plant health in ecosystems; Plant health and climate change; Bio-security and	**4**

	plant health; Plant quarantine	
6	Technological advances in Plant health sciences–Genetic engineering and biotechnology for improvement of plant health; Precision agriculture; Remote Sensing and GIS uses in agriculture; Sensor-based plant protection techniques; Automation of irrigation systems; Drone usages in agriculture, Role of bioinformatics in plant disease management– Whole Genome Sequencing and Microarray Genomics in disease diagnosis; detection of various pathogenicity factors; Role of bioinformatics in raising disease resistance cultivars.	**15**
7	Intellectual Property Rights– Functions of IPR, Various forms of IPR, Importance of IPR in plant health, Plant Variety Protection (PVP) rights, Plant Breeder's rights.	**5**

Practical (Credits -2, 60 Hrs)

1. Visual diagnosis of common diseased plant symptoms and signs–Fungal leaf spots, Bacterial leaf spots, Vein banding, Mosaic and ring spot, Leaf distortion, Powdery mildew, Leaf tip death, Cankers, Fruit discoloration, Wilts, Blights, Damping off.

2. Laboratory testing of plant pathogen by microscopy and pathogen-selective media plates.

3. A field visit and assessment of plant disease incidence and severity.

Reading References:

1. Agrios, G. N. 1997. Introductory Plant Pathology. 4th ed. Academic Press, New York, NY.
2. Hansen, M. A. and R. L. Wick. 1993. Plant disease diagnosis: present and future prospects. Advances in Plant Pathology 10:65-126.
3. Hansen, M. A. and R. L. Wick. 1993. Plant disease diagnosis: present and future prospects. Advances in Plant Pathology 10:65-126.
4. "Law Relating to Intellectual Property Rights" by V K Ahuja (Lexis Nexis Publication)

Course Outcomes (C.Os):

I. The students will have the pleasure of the cognitive development and get the latest exposure in the domain of plant sciences.
II. To mould a responsible citizen who is aware of the most basic domain-independent knowledge including the critical thinking
III. Skill development of for the proper description of the plant health & disease consequences
IV. Internalization of the concept of plant defence mechanisms of the spirit of enquiry.

V. The graduates should be knowledgeable and competent enough to the desired skills in this applied science

SEMESTER: 6

Course Type: **MAJ-9**

Course Code: **BBOTMAJ09C**

Course Title: **Plant Health Science and Technology**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Introduction to Plant Health Science–Definition and Importance of plant health science; Factors affecting plant health – edaphic factors and biotic factors; Basic principles of plant pathology, entomology and nematology; Plant health in response to plant stress physiology	**8**
2	Plant Pathogens and Diseases - Types of plant pathogens (viruses, bacteria, fungi, nematodes); Life cycle of pathogens; Mode of transmission; Plant-pathogen interactions- pathogenicity factors; Phytoalexins in defence mechanism; Systemic and Local acquired resistance; Common plant diseases and their symptoms- Late blight of potato, Black stem rust of wheat, Stem rot of jute, Brown spot of rice; Epidemiology of plant diseases; Disease development and progression; Symptomology; Symptoms variability; Disease diagnosis methods for biotic factors (visual, laboratory tests- PCR, ELISA, BIOLOG test) and abiotic factors; Impact of disease on plant growth and yield.	**15**
3	Plant Disease and Health Management - Principles of integrated pest management; Cultural practices of disease prevention, biological and chemical control methods; Resistance breeding; Soil fertility management; Weed management.	**8**
4	Plant Health in Agriculture–Disease management in agricultural system; Role of plant health in sustainable agriculture; Food safety and plant health.	**5**
5	Plant Health and the Environment–Impacts of plant health in	**4**

	ecosystems; Plant health and climate change; Bio-security and plant health; Plant quarantine	
6	Technological advances in Plant health sciences–Genetic engineering and biotechnology for improvement of plant health; Precision agriculture; Remote Sensing and GIS uses in agriculture; Sensor-based plant protection techniques; Automation of irrigation systems; Drone usages in agriculture, Role of bioinformatics in plant disease management– Whole Genome Sequencing and Microarray Genomics in disease diagnosis; detection of various pathogenicity factors; Role of bioinformatics in raising disease resistance cultivars.	**15**
7	Intellectual Property Rights– Functions of IPR, Various forms of IPR, Importance of IPR in plant health, Plant Variety Protection (PVP) rights, Plant Breeder's rights.	**5**

Practical (Credits -2, 60 Hrs)

1. Visual diagnosis of common diseased plant symptoms and signs–Fungal leaf spots, Bacterial leaf spots, Vein banding, Mosaic and ring spot, Leaf distortion, Powdery mildew, Leaf tip death, Cankers, Fruit discoloration, Wilts, Blights, Damping off.

2. Laboratory testing of plant pathogen by microscopy and pathogen-selective media plates.

3. A field visit and assessment of plant disease incidence and severity.

Reading References:

1. Agrios, G. N. 1997. Introductory Plant Pathology. 4th ed. Academic Press, New York, NY.
2. Hansen, M. A. and R. L. Wick. 1993. Plant disease diagnosis: present and future prospects. Advances in Plant Pathology 10:65-126.
3. Hansen, M. A. and R. L. Wick. 1993. Plant disease diagnosis: present and future prospects. Advances in Plant Pathology 10:65-126.
4. "Law Relating to Intellectual Property Rights" by V K Ahuja (Lexis Nexis Publication)

Course Outcomes (C.Os):

I. The students will have the pleasure of the cognitive development and get the latest exposure in the domain of plant sciences.
II. To mould a responsible citizen who is aware of the most basic domain-independent knowledge including the critical thinking
III. Skill development of for the proper description of the plant health & disease consequences

IV. Internalization of the concept of plant defence mechanisms of the spirit of enquiry
V. . The graduates should be knowledgeable and competent enough to approp

SEMESTER: 6

Course Type: **MAJ-10**

Course Code: **BBOTMAJ10C**

Course Title: **Reproductive Biology of Higher Plants**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Introduction: History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.	**4**
2	Reproductive development: Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.	**6**
3	Anther and pollen biology: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.	**10`**
4	Ovule: Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte–megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac.	**8**
5	Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in	**6**

	pistil; double fertilization.	
6	Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization.	**10**
7	Embryo, Endosperm and Seed: Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms.	**10**
8	Polyembryony and apomixis: Introduction; Classification; Causes and applications.	**6**

Practical (Credits -2, 60 Hrs)

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test. Germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Study of different types.
7. Embryogenesis: Study of development of dicot embryo through permanent slides.

Reading References:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Course Outcomes (C.Os):

I. The students will have the pleasure of the cognitive development and get the latest exposure in the domain of the reproductive biology plant sciences.

II. To mould a responsible citizen who is aware of the most basic domain-independent knowledge

III. To address the brief idea about the Plant Reproductive biology along with the scientists with their Contribution.

IV. To address the molecular basis of flowering along with the external factors responsible for flowering mechanisms.

V. To explore the different aspects of the reproduction like micro and megasporopgensis and micro and Megagametogenesis along with some exceptional features in this regard.

VI. Pollen biology is the most interesting plant & NPC systems have been widely explored.

VII. the Self incompatibly along with the different measures has been explored. CO-6: embryo development both in monocot & dicot along with some exceptions like apomixes, adventives embryonic have been addressed here.

VIII. the dissemination of seed, its structure, anatomical beauty and other features have been highlighted to make the subject more fascinating among the learners.

SEMESTER: 7

Course Type: MAJ-13

Course Code: BBOTMAJ13C

Course Title: Immunology and Applied Microbiology

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Innate and adaptive immune system, Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity.	**6**
2	B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies Antibody generation, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, Chemokine and cytokine , inflammation, hypersensitivity and autoimmunity, congenital and acquired immunodeficiencies, vaccines types.	**16**
3	Reas: Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.	**8**
4	Bioreactors/Fermenters and fermentation processes, Solid-state and liquid-state fermentations; Batch fed batch and	**8**

		continuous fermentations, Components of a typical bioreactor, Types of bioreactors-laboratory, Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.	
5		Microbial production of industrial products in nutrition, healthcare and agriculture, Antimicrobial drugs; Antibiotics: Classification molecular mechanism of mode of action and resistance; Antifungal and antiviral drugs, Amino acids, vitamins, enzymes, organic acids, antitumor, immune suppressants, Biofuel bioplastic, waste water treatment.	**8**
6		Downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying	**6**
7		Microbial interactions; Carbon, sulphur, phosphorus and nitrogen cycles in forest soil and agriculture soil, Soil microorganisms associated with vascular plants (endophytes, epiphytes), **Biological Nitrification Inhibition (BNI),** Bioremediation, Uncultivable microorganisms, Process of making microbial inoculants, Top down, Bottom up, Mixed, Challenge with the establishment of microbial inoculants.	**8**

Practical (Credits -2, 60 Hrs)

Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase urease, phosphatase, lipase activity

Reading References on Immunology:

1. Cellular and Molecular Immunology- Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai

2. Roitt's Essential Immunology- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt

3. Kuby Immunology- Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis

4. Immunology –Saras Publication

Reading References of Applied Microbiology:

1. Prescott L.M; J.P Heavy and D.A. Klein 1993 Microbiology 7th edition Wm C- Brown Publishers

2. Michael T. Madigan, John M. Martinko, Kelly Bender, Daniel P Buckley, David A. Stahl. Brock Biology of Microorganisms, 13th edition, Prentice hall International, Inc

3. Atlas, R.M. 1997. Principles of Microbiology, Second edition. WCK. McGraw – Hill. Prescott LM, Harley JP and Klein DA (2007) Microbiology (7th Edition) McGraw Hill New York

4. Ananthanarayanan, R. and Jayaram Panicker C.K. (2013) Text book of Microbiology. 9th Edition University Press, Hyderabad.

5. Stanbury, P.F., A. Whitaker and Hall S.J. 1995. Principles of fermentation technology. 2nd edition., Pergamon press. Casida, J.E. 1968: Industrial Microbiology, Wiley Eastern. Pastel, A.H. 2012; Industrial Microbiology. 2nd edition. Macmillan India Limited. Cruger and Cruger, Textbook of Industrial Microbiology. 2004

6. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker &S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.

7. Peppler, H. J. and Pearlman, D. 1979. Microbial Technology, Vol 1 ans 2, Academic press.

8. Industrial Microbiology: An Introduction by Waites, Morgan, Rockey & Highton, Blackwell Science, 2001.

9. Biochemical Engineering and Biotechnology by B. Atkinson & F. Mavituna, The Nature Press, 1982. Bioreactor Design and Product Yield (1992), BIOTOL series, Butterworths

10. Chand, Fermentation Biotechnology: Industrial Perspectives.

Course Outcomes (C.O):

I. The main objectives of studying applied microbiology are to exploit microorganisms for a specific product or use.
II. Applied microbiology can overlap with basic microbiology, where methods used and perfected for applied microbiology can become tools for basic understanding of the different prokaryotes and their life style management.
III. It can also envisage the microbial engineering for the best of human welfare.

PROGRAMME OUTCOMES (P.O)

I. Learning Outcome: Students will learn about cells and molecules of Innate and adaptive immune system
II. Students will learn about antibody molecules helps in detection of Biomolecules Students will learn about bioreactors/fermenters and fermentation processes
III. Students will get a hand's on traini9ng about the working principles of the different tools and instruments for the3 production of industrial compounds used in human welfare.

Course Code: **BBOTMAJ11C**

Course Title: **Analytical Techniques in Plant Sciences**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	**Imaging and related techniques:** Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.	**16**
2.	**Cell fractionation**: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.	**6**
3	**Radiolabelling techniques:** Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.	**8**
4	**Chromatography:** Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.	**10**
5	**Biophysical Method:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction, NMR, different types of mass spectrometry.	**8**

6	**Characterization of proteins and nucleic acids:** Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by AGE, PAGE, SDS-PAGE, and two dimensional gel electrophoresis, Isoelectric focusing gels.	**12**

Practical (Credits -2, 60 Hrs)

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. To separate sugars by thin layer chromatography.
3. To separate amino acids by paper chromatography.
4. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
5. Preparation of permanent slides (double staining).

Reading References:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York.U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.

4. Upadhyay, Updhyay and Nath (2009) Biophysical Chemistry : Principles and Techniques, Himalaya Publishing House, Mumbai.

5. Glasel, J. and Deutscher, M. B., "Introduction to Biophysical Methods for Protein and Nucleic acid Research", Academic Press, 1995.

6. Analytical Techniques in Plant Sciences, by Dr. Sanjeeb Kumar Nath , Mahaveer publication , 2022.

7. Practical Manual on Plant Molecular Biology and Analytical Techniques, Dr. S. Girija, Akinik Publications, 2020

Course Outcomes (C.O):

1. To expose the students to different techniques those can be used to study different biological processes.

2. To provide information about the chemical composition of biomass, characterize its properties and also determine the concentration of both organisms

3. The course also offers the different protocols of the use of the different sophisticated tools for exploring the data and to get an idea about the biological processes.

4. Cell fractiontion, radioisotope labeling, crystallography, chromatography and other bio-physical methods have been addressed by this course and it becomes a pleasure of modern biologists.

Programme Outcome (P.O):

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

1. Understand instruments, techniques, lab etiquettes and good lab practices necessary for working in a laboratory.

2. Develop skill in different microscopic techniques.

3. Gain knowledge about the uses of the different tools for diagnosis of the different plants, animals including the human diseases.

4. Students can get the exposure of nucleic acid databases by the use of sophisticated tools like AGE, PAGE, SDS-PAGE etc..

5. Students can learn a lot of bio-physical techniques which can add as the important knowledge to develop their own skills.

SEMESTER: 7

Course Type: MAJ-12

Course Code: BBOTMAJ12C

Course Title: Bioinformatics and Quantitative Biology

(L-P-Tu): 4-2-0

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	**Introduction to Bioinformatics:** Introduction, aim, scope of bioinformatics, Examples of related tools (FASTA, BLAST), databases (GENBANK, PDB) Data generation; Generation of largescale molecular biology data. (Through Genome sequencing, Protein sequencing and microarray).	**10**
2	**Biological Sequence Databases:** Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System, National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, 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, Protein sequences Databases:- Swiss-Prot, UniProtKB, Protein-Protein interaction database:- STRING; Sequence motifs Databases:- Prosite, Pfam, InterPro , Chemical Structure database:- Pubchem, Molecular functions / Enzymatic catalysis databases:- KEGG ENZYME database.	**18**
3	**Sequence Alignments:** Introduction, Concept of Alignment,	**6**

	Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM).	
4	**Molecular Phylogeny:** Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.	**4**
5	**Structural Bioinformatics:** Sequence pattern, motifs and profiles, SCOP, CATH. Prediction of secondary structure of protein.	**4**
6	**Applications of Bioinformatics:** Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Crop improvement.	**4**
7	**Biostatistics:** Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics. Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods, Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations. Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression, student 't' test, Chi-square test for goodness of fit.	**14**

Practical (Credits -2, 60 Hrs)

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.
6. Calculation of mean, standard deviation and standard error.
7. Calculation of correlation coefficient values and finding out the probability.
8. Calculation of 'F' value and finding out the probability value for the F value.

Reading References:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics II Edition. Benjamin Cummings.
4. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
5. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore.
6. The Principles of scientific research, Freedman, P. New York, Pergamon Press.

7. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.
8. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

COURSE OUTCOMES (C.O)

1. To determine the function of genes and proteins, to establish evolutionary relationships, and to calculate the three-dimensional shape of proteins by using computer programs.

2. Analysis of complex sequences, sequence assemble, sequence alignment, general idea of sequencing of nucleic acids and to handle the databases.

3. Get a wide area of the understanding of bioinformatics and its application for solving the different problems in the context of the molecular tools and techniques.

4. Biostatistics has wide scope in applied biology and other domains. The course offers a great deal of information to handle the data by using statistical skills though this course.

PROGRAMME OUTCOME (P.O):

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

1. Gain working knowledge of the practical and theoretical concepts of bioinformatics.

2. Acquiring skill to utilize the computational apps, active data basis and tools in analysis in gene.

3. Students can learn a lot about molecular diagnosis with the use of tools and techniques in the context of the molecular nature of diseases and lots remedial measures.

4. Strident can learn to handle a large dataset using this skills and the programme offers a life style education to maintain their own database using the skills from this programme.

SEMESTER: 7

Course Type: **MAJ-13**

Course Code: **BBOTMAJ13C**

Course Title: **Immunology and Applied Microbiology**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Innate and adaptive immune system, Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity.	**6**
2	B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies Antibody generation, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, Chemokine and cytokine , inflammation, hypersensitivity and autoimmunity, congenital and acquired immunodeficiencies, vaccines types.	**16**
3	Reas: Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.	**8**
4	Bioreactors/Fermenters and fermentation processes, Solid-state and liquid-state fermentations; Batch fed batch and continuous fermentations, Components of a typical bioreactor, Types of bioreactors-laboratory, Constantly	**8**

	stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.	
5	Microbial production of industrial products in nutrition, healthcare and agriculture, Antimicrobial drugs; Antibiotics: Classification molecular mechanism of mode of action and resistance; Antifungal and antiviral drugs, Amino acids, vitamins, enzymes, organic acids, antitumor, immune suppressants, Biofuel bioplastic, waste water treatment.	**8**
6	Downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying	**6**
7	Microbial interactions; Carbon, sulphur, phosphorus and nitrogen cycles in forest soil and agriculture soil, Soil microorganisms associated with vascular plants (endophytes, epiphytes), **Biological Nitrification Inhibition (BNI),** Bioremediation, Uncultivable microorganisms, Process of making microbial inoculants, Top down, Bottom up, Mixed, Challenge with the establishment of microbial inoculants.	**8**

Practical (Credits -2, 60 Hrs)

Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase urease, phosphatase, lipase activity

Reading References on Immunology:

1. Cellular and Molecular Immunology- Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai

2. Roitt's Essential Immunology- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt

3. Kuby Immunology- Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis

4. Immunology –Saras Publication

Reading References of Applied Microbiology:

1. Prescott L.M; J.P Heavy and D.A. Klein 1993 Microbiology 7th edition Wm C- Brown Publishers

2. Michael T. Madigan, John M. Martinko, Kelly Bender, Daniel P Buckley, David A. Stahl. Brock Biology of Microorganisms, 13th edition, Prentice hall International, Inc

3. Atlas, R.M. 1997. Principles of Microbiology, Second edition. WCK. McGraw – Hill. Prescott LM, Harley JP and Klein DA (2007) Microbiology (7th Edition) McGraw Hill New York

4. Ananthanarayanan, R. and Jayaram Panicker C.K. (2013) Text book of Microbiology. 9th Edition University Press, Hyderabad.

5. Stanbury, P.F., A. Whitaker and Hall S.J. 1995. Principles of fermentation technology. 2nd edition., Pergamon press. Casida, J.E. 1968: Industrial Microbiology, Wiley Eastern. Pastel, A.H. 2012; Industrial Microbiology. 2nd edition. Macmillan India Limited. Cruger and Cruger, Textbook of Industrial Microbiology. 2004

6. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker &S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.

7. Peppler, H. J. and Pearlman, D. 1979. Microbial Technology, Vol 1 ans 2, Academic press.

8. Industrial Microbiology: An Introduction by Waites, Morgan, Rockey & Highton, Blackwell Science, 2001.

9. Biochemical Engineering and Biotechnology by B. Atkinson & F. Mavituna, The Nature Press, 1982. Bioreactor Design and Product Yield (1992), BIOTOL series, Butterworths

10. Chand, Fermentation Biotechnology: Industrial Perspectives.

COURSE OUTCOMES (C.O):

I. The main objectives of studying applied microbiology are to exploit microorganisms for a specific product or use.
II. Applied microbiology can overlap with basic microbiology, where methods used and perfected for applied microbiology can become tools for basis of the exploration of the different life processes.
III. Get an idea of the application of immunology and bioinformatics in human welfare of the diverse fields.
IV. The course also offers a recipe of research in the modern field of biological research.

PROGRAMME OUTCOME (P.O):

I. Students will learn about cells and molecules of Innate and adaptive immune system Students will learn about antibody molecules helps in detection of Biomolecules
II. Students will learn about bioreactors/fermenters and fermentation processes.
III. Students will get an idea of the molecular causes behind the outbreak of the diseases along with the identification of diseases in very delicate process.
IV. Immunology and Applied Microbiology can be taken as choice of interest for employability which has high market potential for nowadays.

V. It will also provide a bird's eye view about the alternative way for self employment having high degree of market potential in the context of the growing start ups in our country particularly in the health sector.

SEMESTER: 8

Course Type: MAJ-14

Course Code: BBOTMAJ14T

Course Title: Research Methodology

(L-P-Tu): 4-0-0

Credit: **4**

Practical/Theory: **Theory**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Basic concepts of research: Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature review and its consolidation; Library research; field research; laboratory research.	**10**
2	General laboratory practices: Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions, Dilutions, Percentage solutions, Molar, molal and normal solutions; Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.	**12**
3	Data collection and documentation of observations: Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.	**6**
4	Overview of Biological Problems: History; Key biology research	**6**

	areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics- Transcriptional regulatory network.	
5	Methods to study plant cell/tissue structure: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant Fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.	**6**
6	Plant micro techniques: Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.	**12**
7	The art of scientific writing and its presentation: Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. PowerPoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.	**8**

Reading References:

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

3. Ruzin, S.E. (1999). Plant micro-technique and microscopy. Oxford University Press, New York, U.S.A.

Course Outcomes (C.O):

1. To develop research legitimacy and provides scientifically sound findings.

2. To provide better familiarity with the research topic by properly explaining each concept associated with it.

3. Research methodology eases the process of whole research to the detail procedures for any researcher join at the first time in this unknown journey.

4. The course will offer the idea to understand the basic concept of research along with general laboratory practices followed in course of detail investigation of the coveted domain.

5. Data collection and data interpretation knowledge are other outcomes to be addressed in this course.

6. The key biological research areas particularly poteomics, genomics, transcriptional control, plant biotechnology, tissue culture and cytogenetically tools have widely explored by this course.

7. It also offers an idea about the different methodologies for the documentation of research and its protocol for publication among the academic and research fraternity.

Programme Outcome (P.O):

1. Decision making ability and logical thinking will be generated among the students.

2. Students will be able to determine the reliability and validity of the whole research work. It will tell accurate sources from where data should be taken for studying.

3. It will offer an idea how to develop and design the research activities and planning in the academic schedule.

4. The students will learn the different values of like patience, perseverance, clarity, bravery, and other intangible values required in the passage of time.

5. The programme also directs the incumbents how apparently small issues can lay the foundation of big thought.

6. The programme also enables to develop the mathematical mindset and data management practices which are the call of the time.

7. It also enables to handle big data in GB for wide exploration.

SEMESTER: 8

Course Type: **MAJ-15**

Course Code: **BBOTMAJ15T**

Course Title: **Horticulture Practices and Post Harvest Technology**

(L-P-Tu): **4-0-0**

Credit: **4**

Practical/Theory: **Theory**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	**Introduction:** Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.	**4**
2	**Ornamental plants:** 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, coraltree).	**4**
3	**Fruit and vegetable crops:** 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).	**4**
4	**Horticultural techniques:** Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and	**8**

	border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.	
5	**Landscaping and garden design:** Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.	**6**
6	**Floriculture:** Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.	**6**
7	**Post-harvest technology:** Importance of post-harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing loses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.	**10**
8	**Disease control and management:** 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.	**8**
9	**Horticultural crops - conservation and management:** Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.	**10**

Reading References:

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.

2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.

3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.

4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.

COURSE OUTCOME(C.O)

1. To increase the area, production and productivity of fruits, vegetable, spices Medicinal and floriculture crops.

2. Generating employment, providing raw material to various food processing industries, and higher farm profitability due to higher production of the different types of highly perishable food items.

3. It also gives an idea of the different types of plant diseases caused by the pathogens and pests along with the remedial measures to address the problems in this regard.

4. Landscape gardening and Floriculture give the idea of the large scale production of seedlings from nursery beds having high marketing demand.

5. Biodiversity conservation in general and endangered species in particular is important domains in this time and the students can learn a lot in this regard.

PROGRAMME OUTCOME(P.O):

1. Will be encouraged to conduct basic and applied research in the field of Horticulture.

2. Will be skilled in horticultural practices and get job opportunity in horticultural industries.

3. Will get idea about post-harvest lost and their management practices.

4. The landscape gardening and development of nursery beds to meet up the growing demand of nursery can be addressed after completion of this programme.

5. Students can develop individual start up or the form SHJG as an alternative means of livelihood after getting an exposure of this programme.

SEMESTER: 8

Course Type: **MAJ-16**

Course Code: **BBOTMAJ16T**

Course Title: **Seed Biology and Seed Technology**

(L-P-Tu): **4-0-0**

Credit: **4**

Practical/Theory: **Theory**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Seed structure and related functions, Physiology of Seed, seed health and productivity	**10**
2	Seed Production: Principles and Practices, Principles and Techniques in Vegetable Seed production, Principles and Techniques in crop Seed production, Seed Production in Field Crops, Seed Production and Cultivation of Medicinal and Aromatic Plants (MAPs), Weed Management in Crop Seed Production, Hybrid Seed Production	**20**
3	Seed Quality Testing, Seed Processing, Storage and Deterioration	**10**
4	Seed pathology and Entomology, purity, storage and preservation, Seed Health Technology and quarantine, Seed Biotechnology	**20**

Reading References:

1. Desai BB. 2004. Seeds Handbook. Marcel Dekker. Kelly AF. 1988. Seed Production of Agricultural Crops. Longman. McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall. Musil AF. 1967. Identification of Crop and Weed Seeds. Handbook No. 219, USDA, Washington, DC, USA

2. Seed Science and Technology" by Subir Sen & Nabinananda Ghosh

3. Principles of Seed Technology" by P K Agrawal

4. Objective Seed Technology" by Phundan Singh

5. Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH.

6. Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants. Dept. of Plant Breeding CCS HAU, Hisar.

COURSE OUTCOMES (C.O):

I. Seed science and technology is a multidisciplinary field that is rapidly advancing in tandem with the development of improved plant varieties and other climate-resilient technologies.
II. Provide students with the fundamental knowledge of seed science and technology.
III. It can give the idea of the quarantine practices along with seed testing and certification for healthy and viable seeds.
IV. It also a great deal of information of different type of crops having high market demand.
V. It also offers a detail protocols for the cultivation of medicinal and aromatic plants with high degree of potential in the market.
VI. The course offers a brief idea about seed biotechnology in the context of GM plants production.

PROGRAMME OUTCOMES (P.O):

I. Make skilled and technical human resources available to seed industries so that farmers can obtain high-quality seeds.
II. Students will learn about seed physiology, seed protection, seed pathology, seed entomology, and seed biotechnology.
III. Students can develop their own start up as an entrepreneur for mass production of seedlings of crop plants along with the medicinal and aromatic plants.
IV. Students can become a seed tester and have the authority to certify about the quality of the seeds.

SEMESTER: 8

Course Type: **MAJ-17**

Course Code: **BBOTMAJ17C**

Course Title: **Elements of Forestry**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Forestry: Definition, Scope; Forest as natural Resources; Man and forestry; Sustainability & forestry; Importance of Forest in sustainable ecology and Green house controlling	**5**
2	Forest resources, Forest classification, Farm Forestry, Social Forestry & Agro-forestry; Different Forest related products-Major & Minor; Forest as a source of sustainable economy; Indian Forest & Forestry: Regional and Local Forest resources; Social forestry	**10**
3	Silviculture: Definition, scope & objective. Factors of locality: climatic (Light, temperature & Frost). Topographic (Affect of Altitude, Aspect & Exposure. Edaphic: General, Parental rock influence on vegetation, Pan formation. Biotic: Influence of plants, insects, wild animals, man and his animals; Concept of regeneration of forest.	**10**
4	Mensuration: definition, object and scope; Measurement of diameter and girth; Breast height – Rules of diameter measurement, diameter and girth class. Measurement of height of tree: Principles of height measurement (similar triangle, trigonometric). Volume: Measurement of volume of standing and	**10**

	felled trees, volume table.	
5	Silviculture & forest Management; Classification and objective, Clear felling system: clear strip and alternate strip system. Regeneration by Taungya and /or departmental plantation, Uniform system: Shelter wood system, kinds and pattern of felling, Periodic Block, Indian Irregular shelter wood system, Selection system, Coppice – System: Simple, Coppice with Standard	**10**
6	Principles and objective of Forest conservation and management; Reserve, Protected and un-classed forest. Management classification: Sustained yield and progressive yield, CAI, MAI, sustainable forest, Joint Forest Management: Concept, working and sustainability; Role of JFM in the environmental restoration and biodiversity conservation.	**10**
7	Forest of Purulia; Forest products, Livelihood of Forest dwellers; Role of Forest in eco-tourism in Purulia; Forest & future, NTFP	**5**

Practical (Credits -2, 60 Hrs)

1. Different types of instruments used in Forest mensuration
2. Estimation of stand diameter, height, bark thickness, bark volume, and volume estimation of felled trees;
3. Estimation of trees age, growth of the tree
4. Different practices of the Silvicultural operations
5. Development of nursery and seed bed; Micropropagation techniques of the forest species
6. Study of the different types of Forest vegetation in Purulia district; Social Forestry and its impact on the social life

Reading References:

1. Introduction to Forestry Paperback –C. Nagmani & S.R. Reddy

2. Introduction To forestry and Agroforestry by Parthiban (K T, Scientific Publishers)

3. Text Book Of Introduction To Forestry by Bhol, Mishra, Chauhan

4. Principles and Practices of Silviculture by S.S. Negi

5. Principles and Practice of Silviculture by L.S. Khanna

6. Silviculture of Tree Species A Forestry Field Manual for Shahapurmath, Girish B, Satish Serial Publishing House

7. Silviculture of Indian Trees by Kannur, Siddappa, S S Inamati & Girish B Shahapurmath, I B P S S

8. Practical Manual on Principles and Practices of Social Forestry by Joseph

9. Social forestry by Sushil Kumar, Reliance Publishing House

10. Compendium on Forestry Paperback – by Umakanta Dash & Sourav Ranjan Majumder

11. Introduction to Forestry by Sivakumar, B & B Muralidharan

COURSE OUTCOMES (C.O):

1. The students will have the pleasure of the cognitive development and get the latest exposure in the domain of Forest & Forestry.

2. To mould a responsible citizen who is aware of the most basic domain-independent knowledge including the critical thinking regarding the renewable biological resources.

3. The course offers the concept of sustainability and forest resources as sustainable resources in particular.

4. The course offers detain idea of silviculture and its management practices for the sustainable availability of Minor and major forest products.

5. The role of the different factors are the key components of this course.

6. Forest menstruation has been discussed in detail that has high impact in the socio-economic fields.

7. The course also offers the principles and management of forest resources and conservation in general and environmental management in particular to address the global climate change.

8. The course also offers an idea about the forest resources of Purulia district as the area is popularly known as Jumgal mahal (Forest land)

PROGRAMME OUTCOME (P.O):

1. Skill development of for the proper description of the forest tree species,

2. Internalization of the concept of conservation the channel of the spirit of enquiry.

3. The graduates should be knowledgeable and competent enough to appropriately deliver the key concept of resources mobilisation.

4. The programme offers an idea about alternative issue of employability with respect to the use of forest resources.

5. The programme also builds up some values among the learners like strength, courage, determination, patience and perseverance if it is the outcome in the long term wait.

SEMESTER: 8

Course Type: **MAJ-18**

Course Code: **BBOTMAJ18C**

Course Title: **Restoration Biology and Ecosystem Services**

(L-P-Tu): **4-2-0**

Credit: **6**

Practical/Theory: **Combined**

(Theory, Credit 4)

Unit	Topic	No. of Lectures/Hrs
1	Ecological Concepts, Ecological Succession	**2**
2	Restoration Process ,Steps in the Process ,Understanding Limitations ,Biological Limitations, Soil microbes, Bacteria, Mycorrhizal fungus , Physical Limitations , Rock content ,Soil texture , Soil aggregation , Moisture, Bulk Density, Compaction and Available Rooting Depth, Slope, Topography and Stability, Soil Color , Top soil and sub soil depth , Chemical Limitations, Soil pH, Soil fertility , Overcoming Limitations (a few examples), Revegetation, Mulching, Equipment, Phytoremediation , Collaborative Restoration, Restoration in Various Settings (examples) , mining , metal and mineral ,coal, Grasslands , Tropical Forests , Wetlands, Fire	**20**
3	Management of the Productive Mine Spoil, Rebuilding Soil Structure, Management of Soil pH, Increase soil fertility, Recharging Soil Microbes, Re-establishing Nutrient Cycles, Top Soil Management, Choice of seed or underground structure (Rhizome, bulb, corm etc) for plantation, Selection of C4 or C3	**12**

	plants	
4	Re-vegetation at abandoned land, Agricultural approach, Ameliorative approach, Adaptive approach, Site specific ecotypes, Types of plant, Monoculture (herbs shrubs or trees), mixed culture, native plants, introduced plants	**12**
5	Four Types of Ecosystem Services, Ecosystem functions: The 'supporting' services, From biodiversity to bioperversity: from good science to poor environmental policy, How to avoid bio-perversity (negative outcomes for biodiversity), Provisioning and regulating services, Ecological production functions- Biodiversity & C-sequestration, Cultural and relational services, Coral reefs and ecotourism, Ecotourism in local places like Ajodhya	**14**

Practical (Credits -2, 60 Hrs)

1. Soil pH
2. Soil texture
3. Soil aggregation, Moisture, Bulk Density

Reading References:

Restoration Biology:

1. Bell, S. S., Fonesca, M. S. *et al.* Linking restoration and landscape ecology. *Restoration Ecology* ***5,*** 318–323 (1997).
2. Bradshaw, A. D. Restoration: the acid test for ecology. In *Restoration Ecology: A Synthetic Approach to Ecological Research.* eds. Jordan, W. R., Gilpin, M. E. *et al.* (Cambridge, UK: Cambridge University Press, 1987): 23–29.
3. Falk, D. A., Palmer, M. A. *et al. Foundations of Restoration Ecology*. Washington, DC: Island Press, 2006.
4. Hobbs, R. J. & Harris, J. A. Restoration ecology: Repairing the Earth's ecosystems in the new millennium. *Restoration Ecology* **9,** 239–246 (2001).
5. Hobbs, R. J. & Norton, D. A. Towards a conceptual framework for restoration ecology. *Restoration Ecology* **4,** 324–337 (1996).
6. Hobbs, R. J., Arico, S. *et al.* Novel ecosystems: theoretical and management aspects of the new ecological world order. *Global Ecology and Biogeography* **15,** 1–7 (2006).
7. Holl, K. D., Loik, M. E. *et al*. Tropical montane forest restoration in Costa Rica: overcoming barriers to dispersal and establishment. *Restoration Ecology* **8,** 339–349 (2000).
8. Lamb, D. Large-scale ecological restoration of degraded tropical forest lands: the potential role of timber plantations. *Restoration Ecology* **6,** 271–279 (1998).
9. McKay, J. K., Christian, C. E. *et al*. "How local is local?": a review of practical and conceptual issues in the genetics of restoration. *Restoration Ecology* **13,** 432–440 (2005).

10. Michener, W. K. Quantitatively evaluating restoration experiments: research design, statistical analysis, and data management considerations. *Restoration Ecology* **5,** 93–110 (1997).
11. Montalvo, A. M., Williams, S. L. *et al.* Restoration biology: a population biology perspective. *Restoration Ecology* **5,** 277–290 (1997).
12. Osborne, L. L. & Kovacic, D. A. Riparian vegetated buffer strips in water-quality restoration and stream management. *Freshwater Biology* **29,** 243–258 (1993).
13. Palmer, M. A., Bernhardt. E. S. *et al.* Standards for ecologically successful river restoration. *Journal of Applied Ecology* **42,** 208–217 (2005).
14. Temperton, V. M., Hobbs, R. J. *Assembly Rules and Restoration Ecology*. Washington, DC: Island Press, 2004.
15. Van Andel, J. and Aronson J. *Restoration Ecology*. Malden, MA: Blackwell Publishing, 2006.
16. Young, T. P. Restoration ecology and conservation biology. *Biological Conservation* **92,** 73–83 (2000).
17. Young, T. P., Petersen, D. A. *et al.* The ecology of restoration: historical links, emerging issues, and unexplored realms. *Ecology Letters* **8,** 662–673

Ecosystem services:

1. Cardinale, B.J., R. B. Primack, and J.D. Murdoch, Chapter 5 - The many values of biodiversity, in Conservation Biology, 1st ed. 2019, Oxford University Press: New York, NY. p. 117-139.

2. Cardinale, B.J., R. B. Primack, and J.D. Murdoch, Chapter 6 - Biodiversity and ecosystem services, in Conservation Biology, 1st ed. 2019, Oxford University Press: New York, NY. p. 141-180.

3. Lindenmayer, D.B., et al., Avoiding bio-perversity from carbon sequestration solutions. Conservation Letters, 2012. 5(1): p. 28-36.

4. Tilman, D., et al., Diversity and productivity in a long-term grassland experiment. Science, 2001. 294(5543): p. 843-845.

5. Hungate, B.A., et al., The economic value of grassland species for carbon storage. Science Advances, 2017. 3(4): p. 1-8.

6. Brander, L.M., P. Van Beukering, and H.S.J. Cesar, The recreational value of coral reefs: A meta-analysis. Ecological Economics, 2007. 63(1): p. 209-218.

7. Loomis, J., et al., Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey. Ecological Economics, 2000. 33(1): p. 103-117.

8. Fuller, R.A., et al., Psychological benefits of greenspace increase with biodiversity. Biology Letters, 2007. 3(4): p. 390-394.

9. Lester, S.E., et al., Evaluating tradeoffs among ecosystem services to inform marine spatial planning. Marine Policy, 2013. 38: p. 80-89.

10. Schwenk, W.S., et al., Carbon storage, timber production, and biodiversity: comparing ecosystem services with multi-criteria decision analysis. Ecological Applications, 2012. 22(5): p. 1612-1627.

11. Alix-Garcia, J.M., E.N. Shapiro, and K.R. Sims, Forest conservation and slippage: Evidence from Mexico's national payments for ecosystem services program. Land Economics, 2012. 88(4): p. 613-638.

12. Pyron, A.R., We don't need to save endangered species. Extinction is part of evolution, in Washington Post. 2015, The Washington Post: Washington, D. C.

COURSE OUTCOMES (C.O):

1. The main objective of studying restoration biology is to learn about the science of ecological restoration, which is the practice of renewing and restoring degraded, damaged, **or** destroyed ecosystems and habitats in the environment by active human interferences.

2. Soil management and restoration of soil quality are the two important issues ofg modern days in the context of soil degradation by the random uses of fertilizers and pesticides. The course offers a great deal of information of the matters.

3. The course offers a protocol of soil management in detail.

4. Ecosystem services are another important domains of this course and it offers a great deal of information how to use the ecosystem services and the different regulations for the best of the sustainable development practices in holistic level.

5. Ecotourism is one of the important emerging field in general and the jungal mahal areas in particular. The course offers a great deal of information about ecotourism and its application with special reference to Purulia district.

PROGRAMME OUTCOMES (P.O):

1. Ecosystem services are processes provided by nature that support human life. These services include water catchment and filtration, moderation of floods, pollination, and renewal of soil fertility.

2. Restoration ecology is the scientific study of restoration of the ecosystem and habitat in the context of the growing ecological disaster expedited by global warming and green house effect. The programme offers an idea how to build up the knowledge in this domain.

3. The life style management is another outcome of this programme.

4. Ecotourism is one of the important field having high degree of p[potential in the job market in the context of employment crisis. The programme offers an idea how this domain can be used as one of the alternative of employability.

MINOR COURSES OFFERED

Course Type: **ME-1**

Semester: **1**

Course Code: **BBOTMEA11C**

Course Title: **Mushroom Cultivation Technology**

(L-P-Tu): **2-2-0**

Credit: **4**

(Theory, Credit-2)

Unit	Topic	No. of Lectures/Hrs (30)
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.*	6
2	Cultivation methods: Infrastructure: substrates	10

	(locallyavailable) 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	
3	Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition- Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.	8
4	Food preparation: Delicacies of mushroom and its value addition, Research Centres - National level and regional level. Cost benefit ratio - Marketing in India and abroad, Export Value. National and state institutes related to the activity.	6

Practical: Credit-2 (60 Hrs)

1. Study of different edible mushrooms
2. Preparation of spawn and cultivation of paddy straw (Oyster) mushroom

Reading References:

Bahl, N. (2000). Hand book of Mushrooms. Oxford &Ibh Publishing Co. Pvt Ltd.

Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

Swaminathan, M. (1990). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

Tewari, P. and Kapoor, S.C. (1988). Mushroom cultivation, Mittal Publications, Delhi.

COURSE OUTCOMES (C.OS):

I. Understand the economic importance of mushroom cultivation.
II. To learn the basic tools and techniques used in mushroom cultivation.
III. To learn the skills for developing commercial enterprise of mushroom cultivation.
IV. To develop the skills to manage the microbial culture,
V. To get an idea about the use of renewable biotic resources for the best of human welfare

PROGRAMME OUTCOME (P.OS):

I. Students will be able to know about the different edible mushroom varieties.
II. Students will be able to grow and cultivate mushrooms Students will be able to develop enterprenual skills to develop mushroom cultivation units,
III. Students will learn how to develop the skills and to use the skills as the way of self employment,
IV. To know the utilization of natural resources to earn revenue,
V. To lear to respect the dignity and value of life

Course Type: **ME-4**

Semester: **4**

Course Code: **BBOTMEA24C**

Course Title: **Herbal Technology**

(L-P-Tu): **2-2-0**

Credit: **4**

(Theory, Credit-2)

Unit	Topic	No. of Lectures/Hrs (30)
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
2	Pharmacognosy - systematic position medicinal uses of the following herbs	10

	in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. 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).	
3	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
4	Medicinal plant banks micro propagation of important species (ashwagandha, neem and tulsi- Herbal foods-future of pharmacognosy). National and state institutes related to the activity.	6

Practical: Credits-2/60hrs

1. Morphological and taxonomical study of *Catharanthus roseus, Withania somnifera*, *Clerodendron phlomoides* and *Centella asiatica.*
2. Preliminary Phytochemical Screening of Aqueous Extract of Neem for Alkaloids (Mayer's Test), Flavonoids (Alkali Test), triterpenoids, phenolic compounds (Ferric Chloride Test)

Reading References:

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.

2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.

3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.

4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.

5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.

6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.

7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

COURSE OUTCOMES (C.OS):

I. To gain knowledge about different herbal and medicinal plants of India,
II. To know about the phytochemistry and active principles of these plants and utilize them to make commercially available drugs,
III. To know the use of plants for the treatment of diseases,
IV. To get an exposure of the treatment of uses using plant resources at the minimum cost,
V. To get an idea about the rich heritage of mother India as far as traditional knowledge of health practices,

LEARNING OUTCOME:

I. Students will develop conceptual skill about traditional Indian medicinal system, herbal medicines, their processing, storage and marketing.
II. Gain knowledge about developing commercial enterprise of herbal medicines.
III. Learn the basic tools and techniques to extract the bioactive compounds from plants,
IV. The programme offers an idea to use the vast biological resources to make India atmanirbhar,
V. To get an idea of rich heritage of our country.

Course Type: **ME-5**

Semester: **5**

Course Code: **BBOTMEA35C**

Course Title: **Plant Science I**

(L-P-Tu): **2-2-0**

Credit: **4**

Practical/Theory: **Combined**

(Theory, Credit-2)

Unit	Topic	No. of Lectures/Hrs (30)
1	**Microbes:** General characteristics and economic importance of	10

	bacteria and viruses. **Algae:** General characteristics; range of thallus, reproduction and economic importance **Fungi:** General characteristics, reproduction, ecology and significance.	
2	**Bryophytes:** General characteristics, adaptations to land habit, reproduction and economic importance of bryophytes. **Pteridophytes:** General characteristics, ecological and economic importance of Pteridophytes.	10
3	**Gymnosperms:** General characteristics, ecological and economic importance. **Introduction to plant taxonomy:** Identification, classification, nomenclature, functions of herbarium, important herbaria and botanical gardens of the world and India.	10

Practical: Credit-2(60hrs)

1. Curd organisms through Gram staining
2. Study of *Nostoc, Oedogonium*
3. Study of *Agaricus*
4. Study of *Marchantia*
5. Study of *Selaginella*
6. Study of *Cycas*
7. Identification and taxonomic study of any one genus locally available from family Fabaceae/Solanaceae/Asteraceae
8. Preparation of Herbarium sheets

Reading references:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.

2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.

4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.

5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.

6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

COURSE OUTCOMES (C.OS):

I. To introduce the diversity of microbial, algal and cyanobacterial, fungal worlds, their identifying features, and applications
II. To know about the transition towards land habit, amphibians of the plant kingdom, pteridophytes and gymnosperms, their identification of plants,
III. To know the hierarchical organization of the biodiversity of plant groups,
IV. To get an idea about the identification, nomenclature and the classification of diverse plants,
V. To get an idea of the cellular and organizational complexity of life.

PROGRAMME OUTCOMES (P.OS)

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

I. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance.
II. Gain knowledge about uses of different types of plants,
III. The prgramme offers the diversity of plant kingdom,
IV. The programme offers to think the beauty and diversity of plant kingdom as the outcome of the progressive evolution of life forms.

Course Type: **ME-7**

Semester: **7**

Course Code: **BBOTMEA47C**

Course Title: **Plant Science II**

(L-P-Tu): **2-2-0**

Credit: **4**

Practical/Theory: **Combined**

(Theory, Credit-2)

Unit	Topic	No. of Lectures/Hrs (30)
1	A general account of root, stem with different types of modifications; phyllotaxy; General account of leaves and their modifications; Different types of stipules and their modifications. Different types of inflorescences with examples. Floral morphology with special reference to aestivation, adhesion and cohesion of the floral parts; Types of placentation; Floral formula and floral diagram.	8
2	Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.	5
3	Pollination mechanisms and adaptations, Double fertilization	4
4	Fruits & seeds (types with examples); Seed-structure appendages and dispersal mechanisms.	4
5	Endosperm types, structure and functions; Dicot and monocot embryo development.	5
6	Apomixis and polyembryony: Definition, types and practical applications.	4

Practical: (Credit 2/60 hrs)

1. Identification of type of phyllotaxy from given specimen
2. Identification of inflorescence and determination of floral formula and diagram from given specimen.
3. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
4. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous / campylotropous.
5. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
6. Ultrastructure of mature egg apparatus cells through electron micrographs.
7. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
8. Dissection of embryo/endosperm from developing seeds

Reading References:

1. College Botany: Volume 1 by Hirendra Chandra Gangulee (Author), Kumud Shankar Das (Author), Chittatosh Dutta (Author), Shyamapada Sen (Editor)
2. A Textbook of Botany: Vol II by Bhattacharya Ghosh Hait

3. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

COURSE OUTCOMES (C.Os):

I. To understand morphology of plants,
II. Understand reproduction and developmental changes in plants.
III. The course offers the brief idea about the different physiological and biochemical issues of plants in course of their survival,
IV. The biology of reproduction of higher plants have been addressed by the course contents,
V. Another important aspect of the course is the pollen biology and reproductive beheaviors of plants.

PROGRAMME OUTCOMEAs (P.Os):

I. Students will observe variations that exist in morphological structure of various parts of a plant.
II. Students will develop skill for the proper description of flowering plant using botanical terms
III. They will understand the basic concepts in plant and their diversity ,
IV. The reproductive methods have been addressed as the programme outcomes to get an idea about the magic of the realty of life.,

MULTIDISCIPLINARY COURSE OFFERED

Course Type: MDC-2

Semester: 2

Course Code: BMDBOT2T

Course Title: Biological Sciences

(L-P-Tu): 2-0-1

Credit: 3

Practical/Theory: Theory

Unit: Plant Science: 1.5 credits

1. Plant diversity1.1A brief idea of 5 kingdom concepts;

1.2. Basic idea about cryptogams and Phanerogams with examples including morphological & anatomical features of Plantae with distribution & importance.- 2 Lectures

2. 2.1.Brief idea about ecology;

2.2. Habitat, ecosystem, factors of ecosystem, Energy flow and biogeochemical cycles;

2.3. Taxonomy of flowering plants including identification, nomenclature & classification;

2.4. Concept of phylogeny and Numerical taxonomy (Basic idea).-3 lectures

3. 1.Morphology of Flowering plants with special reference to root, stem, flower, fruits;

3.2. Anatomical features of tissue systems of root stem & leaves with some adaptive features.-

4. Life Process of plants

4.1. Basic idea about Absorption of mineral nutrients,

4.2. Phloem translocation,

4.3. Photosynthesis – basic outline with diversity;

4.4. Respiration-basic outline with reference to energy production;

4.5. Plant growth & development with special emphasis on phyto-hormones and their role on growth & development;

4.6. Nitrogen metabolism with symbiotic mechanisms.

5. Life Process of Plants II:

5.1. Basic idea about Sexual reproduction in flowering plants with special reference to induction of flower,

5.2. Pollination, Pollen-Pistil interaction,

5.3. Microsporogenesis & male gametophyte development, Megasporogenesis & female gametophyte development; Double Fertilization;

5.4. Fruit & Seed development & Dispersal;

5.5. Inheritance pattern of characters (only Mendelism)

6. Plants in human welfare including food, fuel, fodder, medicines and ecological restorations;

crop improvement strategies with special reference to Breeding, tissue culture & biotechnology.-

7. Modern trends in plant biology including application of bioinformatics, AI, Genomics for the Plant biology research in 21st century.

Unit/Group-Animal Science. - 1.5 Credits.

Diversity of Animals and Origin of diversity

1. **Types of animals-Introductions to Different Phyla.**
    1. The Invertebrates
    2. Animals with back bone

2. Origin of Diversity-Evolution

2.1 Origin:

Origin of the Universe, Emergence of Heavy elements, Earth –the beginning, Formation of organic and biological molecules-building blocks of life. Origin of first cells.

2.2. Great Oxygenation event-A metabolic switch and Cambrian explosion.

Explosion of life diversity and some extinction. The basic diversity of animals and their proposed evolutionary orders. Cambrian explosion and establishment of animal forms.

2.3. Prokaryotes and Eukaryotes

2.4. From single cell to metazoan.

2.5. How things change? The basic evolutionary theories. Darwin vs Creationists. Natural selection –the blind watchmaker.

2.6. The Mass extinctions. K-T extinction, Adaptive radiation of mammals. Story of Us-Biological and cultural evolution of *Homo sapiens*.

3. Genes and Inheritance.

3.1. Building blocks of life, DNA, RNA, Proteins and lipids.

3.2. Genes are the basic unit of inheritance and evolution.

3.3. Mutation as source of variation- how genes change the destiny of organisms.

3.4. Genetic engineering – Manipulating genes for pharmaceuticals, high yield crops to Cloning.

4. How the Body Works-basics of human physiology.

4.1. Respiration.

4.2. Blood circulation.

4.3. Excretion.

4.3. Nervous system and brain.

4.4. Adaptation: Surviving extreme climates. Arctic, aquatic and desert.

5. Diseases and our defense.

5.1. Virus, bacteria, protozoa and other parasites.

5.2. Respiratory virus, Vector born diseases, Bacterial diseases-prevention and management.

5.3. Our Immune system- Innate and adaptive

6. Behaviour –Nature or nurture?

The basic units of behaviour. How evolution shape animal behaviour. The selfish gene. Arms race and cooperation- why Thompson gazelle prong, cheetah run fast, lemmings commit suicide but Lady Black Widow spider eats her husband?

7**. Cognition and consciousness. "I think therefore I am"?**

Learning, memory and self-awareness. Cognitive disorders-Autism, Alzheimer's disease, Dementia and Parkinson's Disease-Symptoms, management and treatment.

8. Understanding and protecting Diversity.

8.1. Introduction to Biodiversity.

8.2. Types of Biodiversity.

8.3. Value of Biodiversity.

8.4. Biodiversity hotspots. Biodiversity of India. The IUCN and Red Data Book.

8.3. Protecting Biodiversity through conservation.

8.4. Wild life conservation. Indian acts, Sanctuaries and National parks.

8.5. Protecting endangered flora and fauna.

8.6. India's success in Tiger conservation, conservation of Rhinoceros and Elephants.

REFERENCE BOOKS:

1. A text book of Botany (Vol. I, II, III)- Hait, Bhattacharya & Ghosh,
2. Studies in Botany (Vol. I & II) Guha & Choudhury
3. Udbhidbidda- Sikdar, Sen & Giri
4. College Botany (Vol. I & II) B.P. Pandey,
5. 5.Fundamental Botany- Sen & Giri
6. Krebs, C.J. (2014). Ecology: The Experimental Analysis of Distribution and Abundance, 6th Edition.
7. Odum, E.P. (2008). Fundamentals of Ecology, 2nd Edition.
8. Smith, R.L. (1998). Ecology and Field Biology.
9. Stilling, P. (2012). Ecology: Global Insights and Investigations.
10. Bowman, W.D., Hacker, S.D. and Cain, M.L. (2017). Ecology, 4th Edition.
11. Ricklefs, R.E. and Miller, G.L. (2001). Ecology, 4th Edition.
12. Smith, T.M. and Smith, R.L. (2012). Elements of Ecology, 8th Edition.
13. Campbell, N.A. and Reece, J.B. (2011). Biology, 9th Edition.
14. Futuyma, D.J. (2005). Evolution.
15. Moody, P.A. (1962). Introduction to Evolution, 3rd Edition.
16. Rastogi, V.B. (2012). Organic Evolution, 13th Edition.
17. Ridley, M. (2004). Evolution, 3rd Edition.
18. Russell, P.J. (2016) iGenetics: A Molecular Approach, 3rd Edition. Hildebrand, M. (1995). Analysis of Vertebrate Structure. John Wiley & Sons.
19. Chaki, K.K. Kundu, G. & Sarkar, S. (2005). Introduction to General Zoology. Vol. 1. New Central Book Agency (P) Ltd. Kolkata.
20. Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
21. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd. Kolkata.
22. Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7th Ed. Macmillan Press, London.
23. Young, J. Z. (1981). The Life of Vertebrates. 3rd Ed. ELBS.
24. Chatterjee and Chatterjee Practical Zoology.
25. Alcock: Animal Behaviour: An evolutionary approach (9 ed. 2009, Sinauer)
26. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
27. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge,University Press, UK.
28. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA¬
29. Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach- David B. Lindenmayer, Jerry F. Franklin. 2013.
30. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
31. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation
32. Joseph, B., Environmental studies, Tata Mc Graw Hill.
33. Michael Allabay, Basics of environmental science, Routledge Press.

34. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5th edition) Books/Cole,
35. Mohapatra Textbook of Environmental Biotechnology IK publication.
36. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole.
37. Practical Approaches to the Conservation of Biological Diversity- Richard KenithBaydack, Henry Campa, Jonathan B. Haufler. 1999
38. Rana SVS, Environmentalpollution – Health and Toxicology, Narosa Publication.
39. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press.
40. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and
41. Thakur, I. S., Environmental Biotechnology, I K Publication.
42. Valuation and Conservation of Biodiversity: Interdisciplinary Perspectives… Michael Markussen, Ralph Buse, HeikoGarrelts, MaríaManez Costa, Susanne Menzel, Rainer Marggraf. 2005.
43. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.

COURSE OUTCOMES (C.Os):

I. Learning Outcome: Students will learn about diversity of plant and animal life on earth, how the diversity evolved, the morphological, Physiological, Biochemical & the molecular basis of life;
II. Genetic basis of evolution of diversity, importance of diversity and need for conservation of diversity. Students will appreciate the modern trends in biological research,
III. The course offers a fundamental idea about the origin and diversity of life.
IV. The course offers the biological basis of the reality of life.

PROGRAMME OUTCOMES(P.Os)

I. To develop a mindset to consider the facts and figures on the basis of scientific knowhow.
II. To learn the basic principles of life,
III. To get an idea about the origin, evolution and diversity of life,
IV. To develop the conceptual hierarchy of the different basis of the organization of life

SKILL ENHANCEMENT COURSE OFFERED

Course Type: **SEC-1**

SEMESTER: 1

Course Code: **BBOTSEC01T**

Course Title: **Biofertilizers, Nursery and Gardening**

(L-P-Tu): **3-0-0**

Credit: **3**

Practical/Theory: **Theory**

(Theory, Credit-3/45Hrs)

Unit	Topic	No. of Lectures/Hrs (45)
1	General account about the microbes used as biofertilizer –	5

	Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. (4 Lectures)	
2	*Azospirillum*: isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms. *Azotobacter*: crop response to *Azotobacter* inoculum, maintenance and mass multiplication. (8 Lectures)	5
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)	5
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)	5
5	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (6 Lectures)	5
6	Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. 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	5
7	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 glass house	5
8	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.	5
9	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. National and state institutes related to the activity.	5

Reading References:

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.

2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.

3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.

4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.

5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.

6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming. Akta Prakashan, Nadiad

7. Agrawal, P.K. (1993). Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.

8. Bose T.K. and Mukherjee, D. (1972). Gardening in India, Oxford and IBH Publishing Co., New Delhi.

9. Jules J. (1979). Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

10. Kumar, N. (1997). Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.

11. Sandhu, M.K. (1989). Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.

COURSE OUTCOMES (C.O):

I. To develop in depth knowledge about Biofertilizers,
II. Develop concept of nursery and gardening. Gain knowledge about developing commercial enterprise of nursery.
III. To offer a brief idea about the use of biofertlisers, organic farming and gardening as a part of the enhancement of skills,
IV. To get an idea about sustainable agriculture and organic food production,
V. To explore the use of microbes and fungi for environmental reclamation.

PROGRAMME OUTCOME (P.O):

I. Students will understand the different types and importance of biofertilizers in nursery and gardening as well as in agriculture for a sustainable future
II. To gain knowledge of gardening, cultivation, multiplication, raising of seedlings of garden,
III. To offer the idea for the development of skills as a part of self employment,
IV. To know the resource management at low cost,
V. To develop the small start ups as a part of life style education.