School of Applied Sciences

Centurion University of Technology & Management

B.Sc. (Botany) CBCS syllabus

(2016-17 Admitted Batch Onward)

(Three years programme)

2016

B.Sc. Botany
(Three year programme 2016-17 admitted batch onward)
Course Structure

Semester-I

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSFL1101	English	2-0-0	2
	FCBS0101	Environmental Science		
2	BSBO1101	Phycology and Microbiology	3-1-3	6
3	BSBO1102	Biomolecules & Cell biology	3-1-3	6
4	GE-1[@]	Inter Disciplinary Subject		6
		Total		20

Semester-II

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSFL1101	English	2-0-0	2
	FCBS0101	Environmental Science		
2	BSBO1201	Mycology & Phytopathology	3-1-3	6
3	BSBO1202	Archegoniate	3-1-3	6
4	GE-2[@]	Inter Disciplinary Subject		6
		Total		20

Note: [@] Generic Elective Subjects to be chosen from discipline other than Botany

Semester-III

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSBO2301	Anatomy of Angiosperms	3-1-3	6
2	BSBO2302	Economic Botany	3-1-3	6
3	BSBO2303	Basics of Genetics	3-1-3	6
4	GE-3[@]	Inter Disciplinary Subject		6
5	SEC-1[#]	Skill Enhancement Course-1	0-0-3	2
		Total		26

Semester-IV

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSBO2401	Molecular Biology	3-1-3	6
2	BSBO2402	Plant Ecology and Phytogeography	3-1-3	6
3	BSBO2403	Plant Systematics	3-1-3	6
4	GE-4[@]	Inter Disciplinary Subject		6
5	SEC -2[#]	Skill Enhancement Course-2	0-0-3	2
		Total		26

Note: [#] Any two Skill Enhancement Courses to be chosen from the list given below

Skill Enhancement Courses

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSLS2001	Techniques in Biofertilizer (SEC-1)	0-0-3	2
2	BSLS2002	Skill in Apiculture (SEC-1)	0-0-3	2
3	BSLS2003	Herbal Technology(SEC-2)	0-0-3	2
4	BSLS2004	Techniques in Medical Diagnostics (SEC-2)	0-0-3	2

Semester- V

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSBO3501	Reproductive Biology of Angiosperm	3-1-3	6
2	BSBO3502	Plant Physiology	3-1-3	6
3	DSE*	Discipline Specific Elective-1		6
4	DSE*	Discipline Specific Elective-2		6
		Total		24

Semester- VI

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSBO3601	Plant Metabolism	3-1-3	6
2	BSBO3602	Plant Biotechnology	3-1-3	6
3	DSE*	Discipline Specific Elective-3		6
4	DSE*	Discipline Specific Elective-4		6
		Total		24

Note: *Any four discipline specific elective to be chosen from the list given below

Discipline Specific Elective Courses (DSE)

Sl. No	Code	Subject Name	L-T-P	Credits
1	BSBO3503	DSE I Analytical Techniques in Plant Sciences	3-1-3	6
2	BSBO3504	DSE II Biostatistics	3-1-3	6
3	BSBO3603	DSE III Bioinformatics	3-1-3	6
4	BSBO3604	DSE IV Natural Resource Management	3-1-3	6

Detailed Syllabus

Semester-I

BSFL1101 English

Code	Course Title	Course Type	Credits	L-T-P (hrs)
BSFL1101	English	Theory	2	2-0-0

Module-I: Communication Skill

Communication: Definition, concept

Channels of Communication: Sender, receiver, channel, message, encoding, decoding, context, feedback

Verbal & Non-Verbal Communication: Spoken & written-advantages & disadvantages, Bias free English, Formal & informal style.

Module-II: Communicative Grammar

Time, Tense & Aspect

Verbs of state & events

Modality

Active & Passive voice

Antonyms, Synonyms, Homonyms, one word substitutions & correction of errors

Module-III: Sounds of English

Length of vowels:

Long vowels as in the words feel, food, shoot, card etc.

Short vowels as in the words pen, sun, cut, shut, etc.

Consonants
Stress pattern
Intonation: Rising & Falling.

Text Books:

1. Effective technical communication by M.A.Rizvi

Reference Books:

1. Communicative English & Business Communication by R.K.Panda, J.Khuntia, M.Pati, Alok Publication.
2. Communicative Grammar of English Geoffery Leech

FCBS0101 Environmental Science

Code	Course Title	Course Type	Credits	L-T-P (hrs)
FCBS0101	Environmental Science	Theory	2	3-1-0

Course Objectives:

1. To understand the concept of multi-disciplinary nature of Environmental Science where different aspects are dealt with a holistic approach.
2. Students will develop a sense of community responsibility by becoming aware of environmental issues in the larger social context.
3. One must be environmentally educated.

MODULE-I

Environment and its multidisciplinary nature; Need for public awareness; Renewable and non -renewable resources–forest, water, mineral, land, food and energy resources; Structure and function of ecosystems of forest, grass land, desert and aquatic types.

MODULE -II

Biodiversity and its conservation: Biodiversity at global, national and local levels; Threats to biodiversity - Habitat loss; wild life poaching and man - wildlife conflicts; Endangered and endemic species; conservation measures.

Causes, effects and control measures of pollution, air, water and noise pollution; Nuclear hazards; solid-waste management–Causes, effects and control measures; Management of disasters due to natural causes of floods, earthquakes, cyclones and landslides.

MODULE-III

Social issues and the environment; Sustainable environment, Water conservation measures; Rain water harvesting; Resettlement and rehabilitation of people; Climate change and global warming; Acid rain; Ozone layer depletion; water land reclamation; Consumerism and waste products; Features of Environment Protection Act, Air pollution and Control of Pollution Acts; Water Pollution and its Control Act. Effects of Pollution explosion on environment and public health; Need for value education to Protect environment and resources.

Learning Outcomes:

1. Understand the natural environment and its relationships with human activities.
2. Characterize and analyze human impacts on the environment.
3. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.
4. Design and evaluate strategies, technologies and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Text Book:

1. Anubhav Kaushik & C.P. Kaushik: Environmental Studies-New age International Publishers.

Reference Books:

1. Benny Joseph: Environmental Studies-Tata Mac Graw Hill
2. E. Bharucha: Text book of Environmental Studies for under graduate courses– Universities Press. (Book prepared by UGC Committee.

BSBO1101 Phycology and Microbiology

Code	Course Title	Course Type	Credits	L-T-P (hrs)
BSBO1101	Phycology And Microbiology	Theory + Practice	6	3-1-3

Module-I (17Hrs)

Introduction to microbial world: Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV).

Bacteria: Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms(mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative,asexual and recombination (conjugation, transformation and transduction).

Module-II (17Hrs)

Algae: General characteristics; Ecology and distribution; range of thallus organization; Cell structureand components; cell wall, pigment system, reserve food (of only groups represented in thesyllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, andevolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P.Iyengar).Role of algae in the environment, agriculture, biotechnology and industry.

Module-III (16Hrs)

Cyanophyta and Xanthophyta: Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria.*

Chlorophyta and Charophyta : General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete, Chara,* Evolutionary significance of *Prochloron.*

Phaeophyta and Rhodophyta: Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus, Fucus* and *Polysiphonia.*

Phycology and Microbiology Lab

Experiments:

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).

Phycology

Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia, Procholoron* through electron micrographs, temporary preparations and permanent slides.

Text Books

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.

Reference Books

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

BSBO1102 Biomolecules and Cell Biology

Code	Course Title	Course Type	Credits	L-T-P (hrs)
BSBO1102	Biomolecules & Cell biology	Theory + Practice	6	3-1-3

Module-I (17Hrs)

Biomolecules: Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and 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;

Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

Module-II (16Hrs)

Bioenergenetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, Phosphoglycerides. Coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.

Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group;Classification 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.

The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin ofeukaryotic cell (Endosymbiotic theory).

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.

Module-III (17Hrs)

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; Semiautonomous 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

Cell division Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

Biomolecules and Cell Biology Lab

Experiments:

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum.*
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.

4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study the effect of organic solvent and temperature on membrane permeability.
10. Study different stages of mitosis and meiosis.

Text Books

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.

Reference Books

1. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
2. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 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

SEMESTER-II

BSBO1201 Mycology and Phytopathology

Code	Course Title	Course Type	Credits	L-T-P(Hrs.)
BSBO1201	Mycology & Phytopathology	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Introduction to true fungi: General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.

Chytridiomycota and Zygomycota: Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Synchytrium, Rhizopus.*

Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces, Aspergillus, Penicillium, Alternaria, Neurospora* and *Peziza.*

Basidiomycota : General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

Module-II (17Hrs)

Allied Fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Oomycota: General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.*

Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

Applied Mycology:

Role of fungi in biotechnology; Application of fungi in food industry (Flavour & texture,Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites(Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

Module-III (16hrs)

Phytopathology:

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco, Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

Mycology and Phytopathology Lab

Experiments:

1. Introduction to the world of fungi (Unicellular, coenocytic/ septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria:* Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of 20 *Stemonitis* sporangia.
9. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

Text Books

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.

Reference Books

3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

BSBO1202 Archegoniate

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO1202	Archegoniate	Theory+ Practice	6	3-1-3

Module-I (16Hrs)

Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations.

Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization.

Type Studies- Bryophytes:

Classification (up to family), morphology, anatomy and reproduction of *Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria*; Reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros* and *Funaria* (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Module-II (17Hrs)

Pteridophytes: General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

Type Studies- Pteridophytes: Classification (up to family), morphology, anatomy and reproduction of *Psilotum, Selaginella, Equisetum* and *Pteris* (Developmental details not to be included).Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance.

Module-III (17Hrs)

Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas, Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance.

Archegoniate Lab

Experiments:

1. ***Riccia*** – Morphology of thallus.
2. ***Marchantia***- Morphology of thallus, whole mount of rhizoids & Scales, vertical sectionof thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores,pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. ***Pellia, Porella***- Permanent slides.
5. ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only).
6. ***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.
7. ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide).
8. ***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).
9. ***Equisetum***- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. ***Pteris***- 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 slides)

Text Books

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

Reference Books

3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

Third Semester

Anatomy of Angiosperms

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO2301	Anatomy of Angiosperms	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Introduction and scope of Plant Anatomy

Applications in systematics, forensics and pharmacognosy**.**

Structure and Development of Plant Body

Internal organization of plant body: The three tissue systems, types of cells and tissues.

Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Tissues Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary

elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfercells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Module-II (17Hrs)

Apical meristems

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, TunicaCorpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity insize and shape of leaves; Structure of dicot and monocot leaf, Kranzanatomy.Organizationofroot apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Rootcap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Module-III (16Hrs)

Vascular Cambium and Wood

Structure, function and seasonal activity of cambium; Secondary growth in root and stem.

Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects andreaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation;Anatomical adaptations of xerophytes and hydrophytes.

Anatomy of Angiosperms Lab

Experiments:

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates;xylemfibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Text Books

1. Dickison, W.C. (2000). Integrative Plant Anatomy.Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy.Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

Reference Books

.Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: TheirStructure, Function and Development. John Wiley and Sons, Inc.

BSBO2302 Economic Botany

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO2302	Economic Botany	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Origin of Cultivated Plants Concept of Centres of Origin, their importance with reference to Vavilov's

work.Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.
Cereals: Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.
Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.
Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry.Potato – morphology, propagation & uses.

Module-II (17Hrs)
Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper
Beverages: Tea, Coffee (morphology, processing & uses)
Sources of oils and fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.
Module-III (18Hrs)
Natural Rubber: Para-rubber: tapping, processing and uses.
Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).
Timber plants: General account with special reference to teak and pine.
Fibers: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Economic Botany Lab

Experiments:
1. **Cereals**: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m.starch grains, micro-chemical tests).
4. **Spices:** Black pepper, Fennel and Clove (habit and sections).
5. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. **Sources of oils and fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
7. **Essential oil-yielding plants**: Habit sketch of *Rosa, Vetiveria, Santalum* and *Eucalyptus* (specimens/ photographs).
8. **Rubber**: specimen, photograph/model of tapping, samples of rubber products.
9. **Drug-yielding plants**: Specimens of *Digitalis, Papaver*and *Cannabis.*
10. **Tobacco**: specimen and products of Tobacco.
11. Woods: *Tectona, Pinus*: Specimen, Section of young stem.
12. **Fiber-yielding plants**: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Text Books
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.

Reference Books
Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett_ Publishers.

BSBO2303 Basics of Genetics

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO2303	Basics of Genetics	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Mendelian genetics and its extension

Mendelism: History; 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, Numericals; Polygenic inheritance.

Extrachromosomal Inheritance

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations inyeast;Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

Module-II (17Hrs)

Linkage, crossing over and chromosome mapping

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on genemapping; Sex Linkage.

Variation in chromosome number and structure

Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Gene mutations

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Baseanalogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClBmethod.Role of Transposons in mutation.DNA repair mechanisms.

Module-III (16Hrs)

Fine structure of gene

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

Population and Evolutionary Genetics

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Basics of Genetics Lab

Experiments:

Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1,9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, rolling of tongue, Hitchhiker's thumb and attached ear lobe.

Text Books

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.

Reference Books

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.

Fourth Semester

BSBO2401 Molecular Biology

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO2401	Molecular Biology	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

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, Types of genetic material, 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.

Module-II (17Hrs)

The replication of DNA : Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

Central dogma and genetic code: Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of Mrnatemplate), Genetic code (deciphering & salient features**)**

Transcription: Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

Module-III (16Hrs)

Processing and modification of RNA : Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport.

Translation : Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyltRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Molecular Biology Lab

Experiments:

1. Preparation of LB medium and raising *E.Coli.*
2. Isolation of genomic DNA from *E.Coli.*
3. DNA isolation from cauliflower head.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Text Books

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. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

Reference Books

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.

BSBO2402 Plant Ecology and Phytogeography

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO2402	Plant Ecology and Phytogeography	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Water : Importance: 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: Variations; adaptations of plants to their variation.

Module-II (17Hrs)

Biotic interactions: Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

Population ecology: Characteristics and Dynamics .Ecological Speciation

Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Module-III (16Hrs)

Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

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.

Plant Ecology and Phytogeography Lab

Experiments:

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. Determination of organic matter of different soil samples by Walkley& Black rapid titration method.

5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.

6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.

7. (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. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to 15amiliarize students with ecology of different sites.

Text Books

1. Odum, E.P. (2005). Fundamentals of ecology.Cengage Learning India Pvt. Ltd., New Delhi. 5thedition.
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.

Reference Books

Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

BSBO2403 Plant Systematics

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO2403	Plant Systematics	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Significance of Plant systematics Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; 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.

Taxonomic hierarchy

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Module-II (17Hrs)

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.

Systems of classification

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Module-III (16Hrs)

Biometrics, numerical taxonomy and cladistics

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Phylogeny of Angiosperms Terms and concepts (primitive and advanced, homology and analogy, parallelism andconvergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram)

Plant Systematics Lab

Experiments:

1. 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):
Ranunculaceae - *Ranunculus, Delphinium*
Brassicaceae - *Brassica, Alyssum / Iberis*
Myrtaceae - *Eucalyptus, Callistemon*
Umbelliferae - *Coriandrum /Anethum / Foeniculum*
Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
Solanaceae - *Solanumnigrum/Withania*
Lamiaceae - *Salvia/Ocimum*
Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha*
Liliaceae - *Asphodelus/Lilium/Allium*
Poaceae - *Triticum/Hordeum/Avena*
2. Field visit (local) – Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Text Books
1. Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.*Cambridge University Press, Cambridge.
3. 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.
REFERENCE BOOKS
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*.Harper and Row, New York.

N.B-Students can choose Generic Elective Subjects from other Departments other than Botany Department as specified by UGC.

Skill Enhancement Course

BSLS2001 Techniques in Biofertilizers

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSLS2001	Techniques in Bio fertilizer	Practice	2	0-0-3

Experiments:
1. Isolation of Rhizobium or Aztobacter from plant root nodules& rhizosphere.
2. Identification of soil cyanobacteria from different soil samples.
3. Preparation of culture media
4. Culture of cyanobacteria-
    a.Growth media
    b.Media preparation&Strater culture
    c.Sterilization of mediumin autoclave
    d.Prepare slants & Plates
    e.Inoculation & Growth of Cyanobacteria
5. Cyanobacterial inoculation to plants.
6. To study different types of Mycorrhizal association.
7. Isolation of VAM
8. Methods of Biocompost
9. Methods of vermicomposting
10. Field application of Vermicompost

Text Books:
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 JothiPrakash, E. 2004. Outlines of Plant Biotechnology.Emkay _Publication, New Delhi.

Reference Books

4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. SubhaRao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
6. Vayas,S.C, Vayas, S.

BSLS2002 Skill in Apiculture

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSLS2002	Skill in Apiculture (SEC-1)	Practice	2	0-0-3

Experiments:

1. Study of characteristics of Honey Bee (Queen, Worker & Drawn Bee).
2. Study of social organization of bee colony
3. Study & observation of bee keeping.
4. Study of characteristics of Queen,Worker & Drawn Bee.
5. Demonstration of bee keeping equipment.
6. Observation of pollination & work of Bee
7. Study of beehives
8. Study the technique of collection of Honey.

Text Books:

• Singh S., Beekeeping in India, Indian council of Agricultural Research, NewDelhi

Reference Books:

• Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
• Bisht D.S., Apiculture, ICAR Publication.

BSLS2003 Herbal Technology

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSLS2003	Herbal Technology(SEC-2)	Practice	2	0-0-3

Experiments:

1. Collection of wild herbs & their herbarium preparation.
2. Study of different morphological structure & floral parts of the following plants of locally available medicinal herb.
3. Starch test
4. Proteins & Lipid Test.
5. Study of different types of instruments used in the extraction of phtyochemicals.

a. Soxhlet Apparatus
b. Colorimeter
c. Thin Layer Chromatography
d. High Performance Layer Chromatography
e. UV –Spectrophotometer

6. Extraction of an alkaloid

Text Books:

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.

Reference Books:

1. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
2. Ayurvedic drugs and their plant source. V.V. Sivarajan and BalachandranIndra 1994.Oxford IBH publishing Co.
4. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998.Banarsidass, Delhi.
5. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
6. Pharmacognosy, Dr.C.K.Kokate et al. 1999. NiraliPrakashan

BSLS2004 Techniques in Medical Diagnostics

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSLS2004	Techniques in Medical Diagnostics (SEC-2)	Practice	2	0-0-3

Experiments:

1. Preparation of blood Smear.
2. Study of D.L.C (Differential Leucocyte Count) using Leishman's stain.
3. Platelet count using haemocytometer.
4. Determination of ABO Blood group
5. Estimation of haemoglobin using Sahli's haemoglobinometer
6. Preparation of haemin and haemochromogen crystals
7. Recording of blood pressure using a sphygmomanometer.
8. Study of various Medical imaging.

Text Books:

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers

Reference Books:

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
- Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, II
- Edition, Bhalani Publishing House
- Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for
- Training Courses
- Guyton A.C. and Hall J.E. Textbook of Medical Physiology, Saunders
- Robbins and Cortan, Pathologic Basis of Disease, VIII Edition, Saunders
- Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S.Chand and Co. Ltd.

Fifth Semester

BSBO3501 Reproductive Biology of Angiosperms

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3501	Reproductive Biology of Angiosperm	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Introduction History (contributions of G.B. Amici, W. HofStrasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jenen, J. Heslop-Harrison) and scope.

Reproductive development Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects. Anther and pollen biology Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.

Microgametogenesis; Pollen wallstructure, 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.Ovule Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; **Femalegametophyte**– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonumtype); Organization and ultrastructure of mature embryo sac.

Module-II (17Hrs)

Pollination and fertilization Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization 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 vitropollination;

Modification of stigma surface, parasexual hybridization; Cybrids, in vitrofertilization.

Module-III (16Hrs)

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 Polyembryony and apomixis Introduction; Classification; Causes and applications.

Reproductive Biology of Angiosperms Lab

Experiments:
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: Tetrazoliumtest. Germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: 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: Dissections of developing seeds forendosperm with free-nuclear haustoria.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos atvarious developmental stages; Study of suspensor through electron micrographs

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

BSBO3502 Plant Physiology

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3502	Plant Physiology	Theory+ Practice	6	3-1-3

Module-I (17Hrs)
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.Mineral nutritionEssential 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. :

Module-II (17Hrs)
NutrientUptake: Soil as a nutrient reservoir, transport of ions across cellmembrane, passive absorption, electrochemicalgradient, facilitated diffusion, active absorption, role of ATP, carrier systems,proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
Translocation in the phloem
Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading;Source–sink relationship.

Module-III (16Hrs)
Plant growth regulatorDiscovery, chemical nature (basicstructure), bioassay and physiological role of Auxin, Gibberellins, Cytokinin, Abscisicacid, Ethylene, Brassinosteroids and Jasmonic acid. Nutrient

solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.
Physiology of flowering Photoperiodism, flowering stimulus, florigenconcept, vernalization, seed dormancy.
Phytochrome , crytochromes and phototropins Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR),mode of action.

Plant Physiology lab

Experiments
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 calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study different concentration on Avenacoleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

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

Text & Reference Books:
1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant PhysiologyIntroduction John Wiley and Sons. U.S.A. 4th edition.
TEXT BOOK
2. Taiz, L., Zeiger, E., Mller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6thedition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual.NarosaPublishing House, New Delhi.

Discipline Specific Elective
Analytical Techniques in Plant Sciences

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3503	Analytical Techniques in Plant Sciences	Theory+ Practice	6	3-1-3

Module-I (17Hrs)
Imaging and related techniques Principles of microscopy; Lightmicroscopy; 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. Cell fractionation.
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.
Radioisotopes Use in biological research, autoradiography, pulse chase experiment.

Module-II (17Hrs)
Spectrophotometry Principle and its application in biological research.
Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography, Affinity chromatography.
Characterization of proteins and nucleic acids Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of protenucleicacids; Electrophoresis: AGE, PAGE, SDS-PAGE

Module-III (16Hrs)
Biostatistics Statistics, data, population samples parameters; Representation of Data: Tabular, Graphical;

Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Analytical Techniques in Plant Sciences Labs

Experiments:

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration througLowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining)

Text Books

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rdedition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

Reference Book

3.Ausubel, F., Brent, R., Kingston, R. E.,Moore,D.D.,Seidman, J.G., Smith, J.A., Struhl, K. (1995). ShortProtocolsinMolecular Biology. John Wiley & Sons. 3rdedition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4thedition.

BSBO3504 Biostatistics

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3504	Biostatistics	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

Collection of Data Primary And Secondary: Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data- sampling methods.

Module-II (17Hrs)

Measures of central tendency Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

Module-III (16Hrs)

Correlation Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression

Statistical inference Hypothesis - simple hypothesis - student 't' test - chi square test.

Biostatistics Lab

Experiment

1) Calculation of mean, standard deviation and standard error
2) Calculation of correlation coefficient values and finding out the probability
3) Calculation of 'F' value and finding out the probability value for the F value

Text Books

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data,
Selvin, S., 1991.New York University Press.

Reference Books

4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5 The Principles of scientific research, Freedman, P. New York, Pergamon Press.

Sixth Semester

BSBO3601 Plant Metabolism

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3601	Plant Metabolism	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Concept of metabolism Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

Carbon assimilation Historical background photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII,Qcycle,CO2reduction,photorespiration,C4pathways; **Crassulacean acid metabolism**; Factors affecting CO2 reduction.

Module-II (16Hrs)

Carbohydrate metabolism Synthesis and catabolism of sucrose and starch. Carbon Oxidation Glycolysis : fate of pyruvate, regulation of glycolysis, oxidativepentosephosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH,NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

ATP-Synthesis Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Module-III (17Hrs)

Lipid metabolism Synthesis and breakdown of triglycerides, β-oxidation, glyoxylatecycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

Nitrogen metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Mechanisms of signal transduction

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade

Plant Metabolism Lab

Experiments:

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

Text Books

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology.John Wiley and Sons. U.S.A. 4thedition.
2. Taiz, L., Zeiger, E., MØler, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6thedition.

Reference Books

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

BSBO3602 Plant Biotechnology

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3602	Plant Biotechnology	Theory+ Practice	6	3-1-3

Module-I (17Hrs)

Plant Tissue Culture Historical perspective; Composition of media;Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somaticandzygotic);

Protoplast isolation, culture and fusion;

Tissue culture applications (micropropagation, and rogenesis, virus elimination, secondary metabolit production, haploids, triploids and hybrids; Cryopreservation, Germplasm Conservation).

Recombinant DNA technology Restriction Endonucleases (History, Types I-IV, biological role and application) Restriction Mapping (Linear and Circular); Cloning **Vectors:**Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC)Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Module-II (16Hrs)

Gene Cloning Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; **PCR**

Module-III (17Hrs)

Methods of gene transfer Agrobacterium-mediated, Direct gene transfer By Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reportergenes(**Luciferase, GUS, GFP**).

Applications of Biotechnology Pest resistant (Bt-cotton); herbicide resistant plants(RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice);Improved horticultural varieties (Moondust carnations);

Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase);

GenticallyEngineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Plant Biotechnology Lab

Experiments

1. (a) Preparation of MS medium.
(b)Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc.
2. Study of anther, embryo and endosperm culture micro propagation, micropropagation, somaticembryogenesis & artificia seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Text Books

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam.The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). MolecularBiotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms.Vikas Publication House Pvt. Ltd., NewDelhi. 5thedition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5thedition.

Reference Books

.Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics:
Principles, Techniques and Applications.John Wiley & Sons Inc. U.S.A.

Discipline Specific Elective
BSBO3603 Bioinformatics

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3603	Bioinformatics	Theory+ Practice	6	3-1-3

Module-I (17Hrs)
Introduction, Branches of Bioinformatics, Aim,Scope and Research areas of Bioinformatics
Data bases in Bioinformatics Introduction, Biological Databases, Classification format of Biological Databases Biological Database Retrieval System.

Module-II (16Hrs)
Biological Sequence Databases National Center for Biotechnology Informa) tion (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.
Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

Module-III (17Hrs)
Sequence Alignments Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).
Molecular Phylogeny Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of MoleculaPhylogenetic Prediction.
Applications of Bioinformatics Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

Bioinformatics Lab

Experiments:
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.

Text Books
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.
Reference Book
3. Campbell A. M., Heyer L. J. (2006) Discoovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

BSBO3604 Natural Resource Management (3-1-0)

Code	Course Title	Course Type	Credits	L-T-P (hrs.)
BSBO3604	Natural Resource Management	Theory+ Practice	6	3-1-3

Module- I (16Hrs)
Natural resources Definition and types. **Sustainable utilization Concept,** approaches (economic, ecological and soci cultural). **Land Utilization** (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management
Module-II (17Hrs)
Water Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.
Biological Resources Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan). **Forests** Definition, Cover and its significance

(with special reference to India); Major and minor forest products; **Depletion**; Management.

Module-III (17Hrs)

Energy Renewable and non-renewable sources of energy **Contemporary practices in resource management** EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management. **National and international effort**s in resource management and conservation

Natural Resource Management Lab

Experiments:

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

Text Books

1. Vasudevan, N. (2006). Essentialsof 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.

Reference Book

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