Annexure IV

Semester	Course	Course Title	Course Code	Particulars	L+T+P	Credits
Semester I	I	Cell and Molecular Biology	BOTY 4101	Theory	3+1+0	4
	II	Cytology, Genetics and Genomics	BOTY 4102	Theory	3+1+0	4
	III	Microbiology and Mycology	BOTY 4103	Theory	3+1+0	4
	IV	Lower Botany	BOTY 4104	Theory	3+1+0	4
	V	**Botany Practical I**	BOTY 4105	**Practical**	0+0+2	**2**
	VI	**Botany Practical II**	BOTY 4106	**Practical**	0+0+2	**2**
				Total		**20**

CORE COURSE I
COURSE TITLE: Cell and Molecular Biology
COURSE CODE: BOTY 4101
Credits: Theory-4

UNIT 1
Cell components and their functions
The cell: Structure of prokaryotic and eukaryotic cells.
Cell wall and plasma membrane: Structure, composition and function of plant cell wall. Origin, evolution and composition of biological membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis

UNIT 2

Cytoskeleton: Role and structure of microtubules and microfilaments.
Endomembrane system and peroxisomes:
Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and export; Smooth ER and its role, ER stress.
Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; the vesicular transport: secretory and endocytic mechanism, Lysosomes structure and function; Peroxisome: The role of peroxisome in plant metabolism, its genesis, and its types.
Ribosome - Ribosomes, structure, functional domain and subunit assembly,
Chloroplast and mitochondria: Structure, function and genome organization; Function; Semiautonomous nature of mitochondria and chloroplast, targeting and sorting of protein.
Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus, trafficking between nucleus and cytoplasm.

UNIT 3

Cell division
Eukaryotic cell cycle, mitosis: karyokinesis and cytokinesis, meiosis: various stages of meiosis, significance of crossing over, significance of irregular meiosis; Regulation of cell cycle- check points, role of protein kinases.
Gene and genome: Fine structure of gene, genome organization in prokaryotes and eukaryotes, transfer of genes between nucleus and organelles. DNA and

RNA as genetic material, Mechanism and regulation of DNA Replication in prokaryote and eukaryote, Recombination mechanism and types, and Transposition: prokaryotic and eukaryotic transposon, retrotransposon.

UNIT 4

Transcription: Transcription unit, cistrons, promoter architecture, regulatory sequences, enhancers and repressor: their mechanism of action, transcription mechanism- RNA polymerases, transcription factors, Post Transcription gene regulation: Introns, RNA splicing, alternative splicing, RNA stability - cap structure and function, polyadenylation, PTGS, Transcription mechanism of rRNA and tRNA, RNA degradation. Gene regulation in bacteria: operon system, Positive regulation, negative regulation: lac operon, tryptophan operon, Histidine operon, Ara operon

UNIT 5

Translation: mechanism of translation in eukaryotes and prokaryotes,
Genetic code: Deciphering of the codons, reading frame of a sequence, degeneracy of the genetic code, Wobble hypothesis, variations to the standard genetic code. translational and post translational regulation: posttranslational modifications (Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation). Inhibitors of protein biosynthesis, Co- and post-translational protein traslocation; chaperones and protein folding, Protein degradation

SUGGESTED READINGS:

1. Alberts B, Johnson A, Lewis J, Raff Martin, Roberts K and Walter P. (2007) Molecular Biology of the Cell. Garland Publ., New York.
2. Bonifacino JS, Dasso M, Harford JB, Liipincott-Schwartz J and Yamada KM. (2004) Short Protocols in Cell Biology. John Wiley & Sons, New Jersey.
3. Bregman AA (1987) Laboratory Investigations in Cell Biology. John Wiley & Sons, New York.
4. Hawes C and Satiat-Jeunemaitre B (2001) Plant Cell Biology: Practical Approach. Oxford University Press, Oxford.
5. Hirt RP and Horner DS (2004) Organelles, Genomes and Eukaryote Phylogeny: An evolutionary synthesis in the age of genomics. CRC Press.

6. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008) Molecular Cell Biology. WH Freeman & Co., New York.
7. Ruzin SE (1999) Plant Microtechnique and Microscopy. Oxford Univ. Press, Oxford.
8. Wischnitzer S. (1989) Introduction to Electron Microscopy. Pergamon Press, New York.
9. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
10. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
11. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
12. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
13. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
14. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
15. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
16. 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
17. Weaver, R, F , (2008) Molecular biology 5th edition McGraw-Hill publication.

CORE COURSE II
COURSE TITLE: Cytology, Genetics and Genomics
COURSE CODE: BOTY 4102
Credit: Theory-4

UNIT 1

Mendelian and Non-Mendelian Inheritance: Mendelian laws of inheritance/law of segregation and law of inheritance; Gene interactions (Complementary, supplementary, inhibitory, epistatic, additive, duplicate, polygenic interaction and pleiotropic), linkage, cytoplasmic inheritance; Concepts in Population genetics.

UNIT 2

Prokaryotic and Eukaryotic Genetics: Recombination in viruses and bacteria (transformation, conjugation and transduction); fungal genetics – mating types and genetic exchange, heterokaryosis, parasexual cycle.

Gene Mapping: Basic concepts, gene maps, correlation of genetic and physical maps, molecular markers and construction of linkage maps; Molecular mechanism of recombination; QTL mapping, Gene mapping in prokaryotes.

Mutation: Basic concept, spontaneous and induced mutations, allele theory, physical and chemical mutagens.

UNIT 3

Chromatin Organization, assembly and replication: Nucleosome and higher order organization of chromatin, conformational changes in chromatin and genetic activity, assembly/deassembly of nucleosomes during chromatin replication, centromere and telomere; Chromosome banding patterns: Linear differentiation of chromosome segments, types of chromosome banding, uses of chromosome banding in cytogenetics, Chromosome engineering: transfer of gene through individual chromosome, alien addition and substitution lines; characterization and utility

Sex determination in plants-mechanisms, sex chromosomes;

Chromosomal aberrations: Duplications, deficiencies/deletions, inversions, interchanges/translocations; Role of chromosomal aberrations in crop evolution

Ploidy changes: Haploids, polyploids and aneuploids; Genome analysis in crop plants;

UNIT 4

Epigenetics: Basic concepts and scope, chromatin remodelling histone modifications, methylation, epialleles; their inheritance and role in regulation. Techniques for studying epigenetic mechanisms (immunoprecipitation- ChiP, Chip-Seq)

UNIT 5

Genomics: Concepts Genome and Genomics, genomes sequencing, genomic databases; Physical Mapping of DNA, Restriction site mapping, hybridization mapping. Genome size and C-value paradox, repetitive DNA, split genes, overlapping genes, reverse genetics, genome editing tools (ZFNs, TALENs, CRISPR/Cas9)

SUGGESTED READINGS:

1. A. K. Sharma and A. Sharma. 1990. Chromosome techniques. Butterworths.1990 Ed
2. Ram J Singh (2016), Plant Cytogenetics, third edition, C R C press.
3. Ram J Singh (2017), Practical manuals of plant cytogenetics, C R C Press.
4. Brown, T.A. (1999). Genomes. BIOS Scientific Publishers limited, UK.
5. Gardener, E.J., Simsons, M.J., and Sinustad, D.P. (1991). Principles of Genetics. John Wiley Sons Inc., New York.
6. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C., and Gelbart, W.M. (1993). An Introduction to Genetic Analysis. Freeman and Comapany, USA.
7. Hawley R.S. and Walker, M. Y. (2003) Advanced Genetics analysis-Finding meaning inGenome. Blackwell Publishing, USA.
8. Klug W. S. and Cummings, M. R. (1997). Concepts of Genetics. Printice Hall International,Inc.
9. J E Krebs, E S Goldstein, S T Kilpatrick Lewin's gene (2017). Gene XII. Oxford University Press, New York.

10. Schulz-Schaeffer, J. (1980). Cytogenetics of Plants, Animals and Human. SpingerVerlag,New York.
11. Strickberger, M.W. (2001). Genetics. Prentice-Hall, Inc., Englewood Cliffs, N. Jersey.
12. Smith, J. M. (1998). Evolutionary Genetics. Oxford University Press, New York.
13. Snustab, D. P., Simmons, M. J. and Jenkins, J. B. (1997). Principles of Genetics, John Wileyand Sons, Inc., New York.
14. Hartl, D. L. and Ruvolo, M. (2012). Genetics, Analysis of Genes and Genomes. 8th Edition.Jones and Bartlet, Ontario.

CORE COURSE III
Course Title: Microbiology and Mycology
COURSE CODE: BOTY 4103
Credit: Theory-4

UNIT 1

Viruses: Origin and evolution of microorganisms; Viruses: morphology, architecture, classification, transmission and genetics of viruses, Economic importance of viruses; General account of Prion and Viroid

UNIT 2

Prokaryotes: Ultrastructure, reproduction and economic importance of Mycoplasma, Phytoplasma, Cynobacteria, Archaeaobacteria, Eubacteria and Actinomycetes.

UNIT 3

Fungi: Classification and Phylogeny of fungi. Economic importance of Fungi. Life cycle of representative of each division of Fungi: *phytopthora*, *Rhizopus*, *Penicillium*, *Puccinia*, and *Fusarium.*

UNIT 4

Mycorrhiza: Ectomycorrhiza, Endomycorrhiza and their significance

Plant growth promoting bacteria: Phosphate solubilizing bacteria (PSB); Plant growth-promoting rhizobacteria (PGPR); Consortium of Agriculturally important microbes; Bioremediation; Bacteria as bio-control agent

UNIT 5

Plant Disease: Pathogenesis, Role of enzymes and toxins in plant disease; Plant defence against pathogens; List of major plant diseases caused by virus, phytoplasma, bacteria and fungi; Diagnosis of plant diseases, Management of plant diseases

SUGGESTED READINGS

1. Bergey's Manual of Systematic Bacteriology. Second Edition. Springer.
2. Boyd, R. F. 1984. General Microbiology. Times Mirror Publishers, New Delhi.
3. Pelczar, M. J., Chau, E. C. G. and Krieg, N. R. 1993.Microbiology concepts and application.McGraw Hill, New Delhi.

4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International
5. Alexopoulus, C.J., Mims. C.W. and Blackwel, M. 1996. Introductory Mycology, John Wiley & Sons Ind.
6. Dube, H. S. 2013. An introduction of Fungi. Scientific Publishers. India.
7. Mehrotra, R.S. and Aneja, R.S. 1998. An Introduction to Mycology, New Age Intermediate Press.

CORE COURSE IV
COURSE TITLE: Lower Botany
COURSE CODE: BOTY 4104

UNIT 1

Phycology: Algae in diversified habitats; thallus organization; reproduction; and classification of algae. Salient features of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta

UNIT 2

Algal blooms, algal biofertilizers; algae as food, source of phycocolloids, feed and uses in industry; Lichen – Thallus structure, reproduction and economic importance.

UNIT 3

Bryophytes: Features of Bryophytes, Classification and Alternation of generation in Bryophytes; A general account and phylogeny of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales; Economical importance of Bryophytes.

UNIT 4

Pteridophytes: Salient features of Psilopsida, Lycopsida, Sphenopsida and Pteropsida; Structure and Evolution of Stelar System in Pteridophytes; Evolution of Sporophytes, Alternation of generation, Natural and Induced implications of Apogamy and Apospory, Heterospory and Seed Habit; Economic importance of Pteridophytes.

UNIT 5

Gymnosperms: salient features, Classification; A general account of structure, reproduction and evolutionary relationships of Progymnosperms, Cycadofilicales, Cycadeoidales, Glossopteridales, Pentoxylales, Cycadales, Cordaitales, Coniferales, Ginkgoales, Taxales, Ephedrales, Welwitchiales, Gnetales. Economic Importance of Gymnosperms

SUGGESTED READINGS

1. Kumar, H. D. 1988. Introductory Phycology. East-West Press Ltd., New Delhi.

2. Round, F. E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.
3. Morris, I. 1986. An Introduction to the Algae. Cambridge University Press, U.K.
4. Morris, I.1986. An Introduction to the Algae. Cambridge University Press, U.K.
5. Parihar, N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
6. Chopra, R.N. and P. K. Kumra. Biology of Bryophytes. Wiley Eastern Ltd., New Delhi, 1988.
7. Dyer, A. F. and J. G. Duckett.(Eds.). The Experimental Biology of Bryophytes. Academic press, London, 1984.
8. Goffinet, B. and A.J. Shaw. Bryophyte Biology. 2 nd Ed. Cambridge Univ. Press, Cambridge, 2009.
9. Parihar, N.S. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad.
10. Puri, P. 1980, Bryophytes. Atma Ram & Sons, Delhi.
11. Round, F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.
12. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperm New Age International pvt. Ltd., NewDelhi.
13. Sunderrajan, S.2007. Introduction to pteridophyta, New Age International Publishers, New Delhi.

CORE COURSE V
COURSE TITLE: Practical I
COURSE CODE: BOTY4105
Credits: Practical-2

Cytology, Genetics and Genomics

1. Preparation of mitotic and meiotic spreads and analysis of various stages of cell division (Phlox, Allium and Rhoeo).
2. Extraction of genomic DNA from plants by CTAB method.
3. Molecular markers: SSR, CAPS, RAPD.
4. Analysis of molecular polymorphism in parental lines and derived mapping population using different types of molecular markers.
5. Construction of a linkage map using available data.
6. Mutagenesis experiments in E. coli.
7. QTL mapping (Theoretical using available data)
8. Meiosis and mitotic studies of given plant materials.
9. Chromosomal analysis of given plant materials.
10. To test the goodness of fit of Data by chi square test.
11. Karyotypic analysis and ideogram
12. Experiments in Neurospora genetics. Basis of specific ascospores arrangement in side ascus of Neurospora.

Cell and Molecular Biology

1. To exemplify the use of phase contrast and fluorescence microscopy in plant biology by studying phase objects and autofluorescent specimens or those stained with fluorochromes, such as, carbofluoresceindiacetate, aniline blue, calcofluor white, Evans blue and neutral red.
2. Isolation of DNA and RNA.
3. Visualization of DNA and RNA by electrophoresis.
4. Isolation and separation of proteins.
5. PCR amplification of selected genes
6. Quantification of DNA, RNA and protein by spectrophotometer.
7. Isolation and purification of nuclei and their staining with Feulgen stain or DAPI.

8. Isolation of mitochondria and their visualization with Janus green B and mitotracker.
9. Isolation of chloroplasts and determination of number of chlorophyll molecules per chloroplast.
10. In silico analysis (sequence comparison) of mitochondrial and chloroplast genes for identification of the loci for interspecific discrimination.
11. Multiple sequence alignment and ontology based database searches on selected plant cytoskeletal genes to deciphering the molecular phylogeny of cytoskeleton genes.
12. Measurement of cell size by the technique of micrometry.
13. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).

*Minimum five or six experiments should be done from each unit

CORE COURSE VI
COURSE TITLE: Practical II
COURSE CODE: BOTY 4106
Credits: Practical-2

Microbiology and Mycology

1. Morphological and reproductive study of different groups of fungi through preparation of whole mounts and sections
2. Demonstration of phosphate solubilization by bacterial isolates using PVK medium
3. Study of types of root nodules/morphology/anatomical preparation showing infection zone
4. Isolation of fungal and bacterial pathogens from leaves.
5. Isolation of fungal and bacterial pathogen from stems fruits and other aerial plant parts.
6. Microscopic preparation and study of pathogenic microbes.
7. Detection of plant viruses from infected leaf tissue using ELISA and Western Blot.
8. Screening for antagonism.

Lower Botany

1. Morphological and reproductive study of different groups of algae through preparation of whole mounts and sections
2. Morphological and reproductive study of different groups of bryophytes through preparation of whole mounts and sections
3. Morphological and reproductive study of different groups of pteridophytes through preparation of whole mounts and sections
4. Morphological and reproductive study of different groups of gymnosperms through preparation of whole mounts and sections

Semester	Core Courses	Courses Titles	Courses Code	Particulars	L+T+P	Credits
Semester II	VII	Developmental and Reproductive Biology	BOTY 4201	Theory	3+1+0	4
	VIII	Systematics and evolution	BOTY 4202	Theory	3+1+0	4
	IX	Plant Physiology and Biochemistry	BOTY 4203	Theory	3+1+0	4
	X	Techniques in Plants Sciences, Biostatistics and bioinformatics	BOTY 4204	Theory	3+1+0	4
	XI	**Botany Practical III**	**BOTY 4205**	**Practical**	0+0+2	**2**
	XII	**Botany Practical IV**	**BOTY 4206**	**Practical**	0+0+2	**2**
		Seminar I	BOTY 4207			1
				Total		**21**

Core Course VII
Course Title: Developmental and Reproductive Biology
Course Code: BOTY 4201
Credits: Theory-4

UNIT 1

Plant development: Shoot apical meristem (SAM) and development of shoot; Cell to cell communication; Regulation of tissue differentiation with special reference to xylem and phloem, secretory ducts and laticifers; Wood development in relation to environmental factors

UNIT 2

Differentiation and development of plant organs; Pattern formation in plants; Differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll; Programmed cell death, aging and senescence; Root apical meristem (RAM) and development of root(s), lateral roots and root hairs; Hormonal control of root development

UNIT 3

Reproduction: Vegetative and sexual reproduction; flower development; genetics of floral organ differentiation; homeotic mutants in Arabidopsis, Antirrhinum and Petunia

Male gametophyte: microsporogenesis, pollen development and gene expression; pollen germination, pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos

UNIT 4

Female gametophyte: Ovule development; megasporogenesis; organization and structure of the embryo sac. Pollination, pollen-pistil interaction, self incompatibility in plants, Double fertilization and in vitro fertilization in plants, Polarity during embryogenesis, Somatic embryogenesis

UNIT 5

Endosperm development: Early, maturation and desiccation stages; Embryogenesis; Storage proteins of endosperm and embryo; polyembryony; apomixes; Seed development, Fruit development and maturation: biochemistry and molecular biology aspects; Seed dormancy: Importance and types

SUGGESTED READING

1. Bewley, J. D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press, New York.
2. Bhojwani, S. S. and Bhatnagar, S. P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition), Vikas Publishing House, New Delhi.
3. Burgess, J. 1985. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.
4. Fahn, A. 1982. Plant Anatomy (3rd edition), Pergamon Press, Oxford.
5. Fosket, D. E. 1994. Plant Growth and Development. A Molecular Approach. Academic Press, San Diego.
6. Howell, S. H. 1998. Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.
7. P. Maheshwari, An introduction to embryology of angiosperms

Core Course VIII
Course Title: Systematics and Evolution
Course Code: BOTY 4202
Credits: Theory- 4

UNIT 1

History of developments in taxonomy: Linnaean to post-Linnaean era; Outline of classification of Angiosperms; Hutchinson, Takhtajan, Cronquist, merits and demerits; Systematics- concepts and components; International code of Botanical Nomenclature; Principles: rules and recommendations; priority; typification; Rules of effective and valid publications; retention and choice of names.

UNIT 2

Taxonomic features, systematic phylogeny and economic importance of families: Rananculaceae, Magnoliaceae, Capparidaceae, Combretaceae, Rosaceae, Asteraceae, Apocynaceae, Asclepiadaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, cucurbitaceae, Bignoniaceae, Lamiaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Orchidacae, Zingiberaceae, Araceae, Cyperaceae and Poaceae.

UNIT 3

Numerical taxonomy: Aims and objectives, characters and attributes, OTUs, coding, cluster analysis, merits and demerits; Chemotaxonomy: Role of phytochemicals in taxonomy; Embryology in relation to taxonomy; Molecular approaches to plant taxonomy: Application of DNA markers in angiosperm taxonomy; molecular phylogeny.

UNIT 4

Evolutionary ecology-concepts and principles; Microevolution - theory and concepts; Species and speciation; Phylogenetic systematics; Macroevolution - inferring phylogenies; Diversity and classification of flowering plants.

UNIT 5

Biological diversity-concepts and applications; Diversity: patterns, indices and applications, hot spots; herbarium.

SUGGESTED READINGS

Grant, W. F. 1984. Plant Biosystematics. Academic Press, London.
Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F. and Donoghue, M. J. 2007. Plant Systematics: A Phylogenetic Approach, 3rd ed. Sinauer.
Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. Plant Systematics for 21st Century. Portlant Press Ltd., London.
Radford, A. E. 1986. Fundamentals of Plant Systematics. Harper & Row Publications, USA.
Simpson, M. G. 2006. Plant Systematics. Elseiver & Academic Press.
Singh, G. 2005. Plant Systematics. Oxford & IBH, New Delhi.
Takhtajan, A. L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.
Woodland, D. W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey.

CORE COURSE IX
COURSE TITLE: Physiology and Biochemistry
COURSE CODE: BOTY 4203
Credit: Theory-4

UNIT 1

Dissociation of Water and biological Buffers; Principles of thermodynamics in biology, concepts of Bioenergetics.

Transport of Water and Solute

Soil water- plant atmosphere continuum; Water absorption by roots, water transport through the xylem, Transpiration and guttation.

Mineral nutrition; essential nutrients deficiency and plant disorder, soils roots and microbes; Solute transport molecular motors and pumps.

UNIT 2

Biomolecules: Structure and function of amino acid**,** Protein, lipid, carbohydrate, nucleotide and nucleic acid and vitamins

Enzymes: origin and evolution of biocatalytic reactions; mechanism of action of enzyme, enzyme kinetics, enzyme inhibition, regulation of enzymatic activity significance of ribozymes; abzymes; artificial enzymes; enzyme technology

UNIT 3

Photosynthesis: light reaction, carbon assimilation (C_2, C_3, C_4 and CAM metabolism), phloem translocation, evolution of electron transport chain; ATP synthesis.

Respiration: Aerobic and anaerobic, carbohydrate metabolism and lipid metabolism,

UNIT 4

SIGNAL TRANSDUCTION

Second messengers, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signaling mechanisms and their regulation.

Sensory Photobiology:

Phytochromes: Structure, function and mechanisms of action.

cryptochromes and phototropins: stomatal movement; scotomorphogenesis and photomorphogenesis

UNIT 5
GROWTH AND DEVELOPEMENT

Plant growth regulators (PGR): Concept of PGR as chemical messengers, techniques for detection and quantitation of PGR, classical approaches and use of mutants in understanding PGR actions, hormones in defense against abiotic and biotic stresses, synthetic regulatory compounds and their uses.

Developmental Biology of Plants: vegetative and flower development. Plant growth, development and senescence. Physiological aspect of biotic interaction and abiotic stress

Tropic Movement in Plants: growth in response to directional stimuli;

SUGGESTED READINGS:

1. Ainsworth C (2006) Flowering and its Manipulation, Annual Plant Reviews, Vol. 20. Blackwell Publishing, Oxford, U.K.
2. Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology ofPlants, American Society of Plant Physiologists, USA.
3. Davies P J. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition,Kluwer Academic Publisher, Dordrecht, The Netherlands.
4. Jordan BR. (2006) The Molecular Biology and Biotechnology of Flowering, 2nd Edition,CAB International, Oxfordshire, U.K.
5. Lodish H, Berk A, Kaiser CA and Krieger M. (2008) Molecular Cell Biology, 6th Edition,W.H. Freeman and Company, New York, USA.
6. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H.Freeman and Company, New York, USA.
7. Taiz L and Zeiger E. (2017) Plant Physiology, 4th Edition, Sinauer Associates Inc.Publishers, Massachusetts, USA.
8. Slisburry and Ross, Plant Physiology, 3rd edition, CBS publisher and distributers.
9. Hopkins, W.G, Introduction to plant physiology, 4th edition,

CORE COURSE X
COURSE TITLE: Techniques in Plant Science, Biostatistics and Bioinformatics
COURSE CODE: BOTY 4204

UNIT 1

Microscopic techniques: light microscopy, resolving powers of different microscopes, microscopy for living cells, scanning and transmission electron microscopes, confocal microscopy.

UNIT 2

Fractionation Methods: Centrifugation, Electrophoresis: Paper and Gel Electrophoresis
Chromatography: Paper chromatography; Column chromatography, Spectrophotometry: UV/visibles, Atomic Absorption Spectroscopy, fluorescence spectroscopy.

UNIT 3

Radiolabeling techniques: Detection and measurement of different types of radioisotopes used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
Histochemical and Immunotechniques: Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

UNIT 4

Statisitcal Methods: Central tendency, dispersion, standard error, coefficient of variation; Probability distributions (normal, binomial of Poission) and Confidence limits. Test of statistical significance (t-test, Chi-square): Analysis of variance- Random Block Design and its application in plant breeding and genetics; Correlation and Regression.

UNIT 5

Introduction to Bioinformatics: Databases: NCBI, EMBL, Genbank. Sequence alignment, phylogenetic prediction, Gene prediction, Protein

classification and structure prediction, Genome analysis. Bioinformatics tools and softwares: BLAST, ORF finder, Primer 3.

SUGGESTED READING

1. Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. Maryland, USA
2. Gustafson, J. P. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA
3. Brown, T. A. 1999. Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
4. Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Science Ltd., Oxford, UK
5. Singer, M. and Berg, P. 1991. Genes and Genomes: A Changing Perspective. University Science Books, CA, USA
6. Attwood, T.K. and Parry-Smith, D.J. 2004. Introduction to Bioinformatics. Pearson Education (Singapore) Pvt. Ltd
7. David, E. (Ed.) 2007. Plant Bioinformatics: Methods and Protocol. Humana Press, New Jersey, USA
8. Wilson, K., Walker, J. (2005) Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, Cambridge University Press
9. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. USA
10. 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
11. Mishra, B.N. and Mishra M.K. 1989.Introductory Practical Biostatistics. Naya Prokash Publication, Calcutta
12. Rao, Sundar P.S.S. and Richard, J. 2011.Introduction to Biostatistics and Research Methods.(4th Ed), PHI Learning Pvt. Ltd., New Delhi
13. Edmondson, A., Druce, D. (1996) Advanced Biology Statistics, Oxford University Press

14. Williams, Brain. 1993. Biostatistics- Concepts and Applications for Biologist. Chapman & Hall, London

Core Course XI
Course Title: Botany Prabtical III
Course Code: BOTY 4205
Credits: Practical-2

Developmental and Reproductive Biology

PRACTICAL

1. Study of living shoot apices by dissections using aquatic plants such as Ceratophyllum and Hydrilla. .
2. Study of different types of leaf arrangement.
3. Microscopic examination of vertical sections of leaves such as Cannabis, tobacco, Nerium, maize and wheat to understand the internal structure of leaf tissues and trichomes, glands, etc. Also study the C3 and C4 leaf anatomy of plants.
4. Study of epidermal peels of leaves such as Coccinia, Gaillardia, Tradescantia, Notonea, etc. to study the development and final structure of stomata and prepare stomatal index.
5. Study of L.S. and T.S. of monocots and dicots roots
6. Study of leguminous roots with different types of nodules.
7. Study of microsporogenesis and gametogenesis in sections of anthers.
8. Tests for pollen viability using stains and in vitro germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
9. Estimating percentage and average pollen tube length in vitro.
10. Study of nuclear and cellular endosperm through dissections and staining.
11. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (Syzygium cumini), etc. by dissections.
12. Study of seed dormancy and methods to break dormancy

Systematics and Evolution

PRACTICALS

1. Live plants/ Herbarium specimens of the following families will be provided in the class fordescription and identification (classification based on APG II, 2003): Basal Angiospermand Magnoliids: Monocots: Commelinids: Basal Eudicots and Caryophyllids:Ranunculaceae, Rosids: Asterids.
2. Phylogenetic analyses using Software.
3. Local flora study

CORE COURSE XII
COURSE TITLE: Botany Practical IV

COURSE CODE: BOTY 4206
Credit: Practical-2

PRACTICALS

1. Assay for different enzymes in leaf tissues.
2. Comparative assessment of methods for protein quantitation.
3. Study of enzyme kinetics for determination of Km value, nature of inhibition competitive/non competitive.
4. Study of enzyme kinetics for effect of time/ enzyme concentration/ pH.
5. Extraction of proteins from plant tissue and their quantitative (Bradford's) and qualitative (SDS, PAGE gel) analysis.
6. Qualitative and quantitative analysis of photosynthetic pigments and anthocyanins by spectrophotometric and chromatographic techniques.
7. PAGE analysis of pigment-protein complexes from chloroplasts.
8. Impact of stress on stomatal opening and closing using potassium chloride.
9. Measurement of stomatal size using epoxy raisin

Techniques in Plant Science, Biostatistics and Bioinformatics

1. Verification of Beer's and Lambert's law for spectrophotometry
2. To separate sugars and lipids by thin layer chromatography
3. Isolation of chloroplasts by differential centrifugation
4. Estimation of leaf pigments by spectrophotometry.
5. Colorimetric estimation of biochemical and plant extracts.
6. Assay of enzymes using spectrophotometry.
7. To separate chloroplast pigments by column chromatography
8. To estimate protein concentration through Lowry's methods

9. To separate proteins using PAGE
10. To separation DNA (marker) using AGE
11. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
12. Demonstration of ELISA.
13. Labeling and scoring of molecular markers and phylogenetic tree preparation through NTYSIS software, and analysis of genetic diversity relationship
14. Database searching and sequence retrieval of nucleic acids and proteins
15. BLAST (n and p-blast)
16. Primer designing
17. Multiple sequence alignment using ClustalW
18. Computation of Central tendency
19. Computational techniques for ANOVA
20. Computational techniques for Correlation and Regression