COURSES OF STUDIES

for

M.Sc. Botany
(2020-2021)

FAKIR MOHAN UNIVERSITY
Vyasa Vihar, Balasore-756089, Odisha

P.G. DEPARTMENT OF BOTANY, F.M. UNIVERSITY

1st Semester		
Paper No.	**Course title**	**Maximum marks/Credits**
BOT-411	Plant Diversity – I (Microbiology/Algae/Fungi)	**4CH**
BOT-412	Cell and Molecular Biology	**4CH**
BOT-413	Plant Biochemistry	**4CH**
BOT-414	Instrumentation, Biostatistics and Computer Application	**4CH**
BOT-415	Practical relating to BOT-411, BOT-412, BOT-413, BOT-414	**8CH**
2nd Semester		
BOT-421	Plant Diversity – II (Bryophyta / Pteridophyta / Gymnosperm)	**4CH**
BOT-422	Genetics and Plant Breeding	**4CH**
BOT-423	Plant biotechnology and Tissue Culture	**4CH**
BOT-424	Ecology and Environmental Biology	**4CH**
BOT-425	Practical relating to BOT-421, BOT-422, BOT-423, BOT-424	**8CH**
	• Non Credit Course through MOOC	
3rd Semester		
BOT-531	Plant Systematics & Economic Biology	**4CH**
BOT-532	Plant Physiology	**4CH**
BOT-533	Plant Anatomy and Developmental Botany	**4CH**
BOT-534	CBCS (Choice Based Credit System)	**4CH**
BOT-535	Practical relating to BOT-531, BOT-532, BOT-533, BOT-534	**8CH**
	• Non Credit Course on Fakir Mohan Studies	
4th Semester		
BOT - 541	Elective – I (Special Paper)	**4CH**
BOT – 542	Elective – II (Special Paper)	**4CH**
BOT - 543	Practical relating to BOT-541, BOT-542	**8CH**
BOT - 544	Dissertation	**8CH**

1st Semester

Subject Code	Subject Name	Credit	Int. Mark	Ext. Mark
BOT-411	Plant Diversity- I (Microbiology/Algae/Fungi)	4	10	40

Objective	Microorganisms can be found in almost every natural element on the planet and they play key roles in nutrient cycling, biodegradation, climate change, food spoilage, the cause and control of disease, and biotechnology. So, the objective of this paper is to enhance the knowledge of students about the structure, reproduction and role of different microorganisms.
Pre-Requisites	Basic knowledge about the prokaryotic and eukaryotic cells.
Teaching Scheme	Regular classroom lectures with visual information.

Detailed Syllabus

Unit	Topics	Hours
I	History and development of microbiology, Bergey's manual for classification of microbes, Whittaker's 5 kingdom concept, Carl Woese's 3 domain classification, Characteristics of prokaryotic and eukaryotic microbes, Isolation, Culture and maintenance of microorganisms, Roles of microbes in agriculture and industry, Microbial growth, Factors influencing growth of microbes.	14
II	Structure and reproduction of Eubacteria, Cyanobacteria, Archaea, Actinomycetes, Mycoplasma, Rickettsiae, Spirochaetes, Virus, Viroids, Prions, Biofertilizers: cyanobacteria, *Rhizobium*, Mycorrhizae and *Azotobacter*. Plant diseases caused by viruses, Bacteria, and Mycoplasma, Disease symptoms, Modes of infection and dissemination, Disease resistance, Defense mechanism and control methods.	10
III	Algae in diversified habitats (terrestrial, freshwater and marine), Classification based on pigment, food reserve and flagella, Thallus organization, Reproduction. Life cycles in algae. Salient features of Chlorophyta, Bacillariophyta, Dinophyta, Phaeophyta and Rhodophyta, Algal bloom and toxins, Algae as food, Seaweed cultivation.	10
IV	Classification of fungi, Structure and reproduction of Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Degeneration of sex in fungi, Nutrition in fungi, Heterothallism,Heterokaryosis.Plant diseases caused by fungi, Disease symptoms, Modes of infection and dissemination, Disease resistance, Defense mechanism and control methods, Hostparasite relationship.	14
	Total	48

Text Books:

1. Brock Biology of Microorganisms by M.T. Magdigan J.M. Martinako, J. Parker.
2. Microbiology by M. J. Pelczar, E.C.S. Chan and N.R.Kreig.
3. General Microbiology by RY.Stainer, J.I.Ingharam, M.I. Wheelis.
4. Algae by B.R. Vashistha.
5. Fungi byB.R. Vashistha.

Sub Code	Subject Name	Credit	Int. mark	Ext. Mark
BOT-412	**Cell and Molecular Biology**	4	10	40
Objectives	The basic objective of the course is to strengthen the student basics on cellular structure and function and their role in lively activities			
Pre-requisites	Knowledge on cellular structure of living beings			
Teaching Scheme	Class room lectures with use of ICT and Practical's of cytological and physio-bichemicals			
	Detailed Syllabus			
Unit -I	Cell Wall: Structure & functions; Biogenesis; Growth. Plasma membrane: Structure, Models, Electrical properties of membrane & functions; Sites for ATPases, Ion carriers, Channels and pumps; Receptors Plasmodesmata: Structure; Role in movement of molecules & macromolecules; Comparison with gap junctions. Cell shape & motility: The cytoskeleton, Organization & role of microtubules and microfilaments, Motor movements, Implications in flagellar& other movements. Cell cycle and apoptosis: Control mechanisms, Role of cyclins & cyclin dependent kinases, Retinoblastoma & E2F proteins, Cytokinesis & cell plate formation, Mechanism of programmed cell death. *Plant Vacuole*: Tonoplast membrane; ATPases, Transporters as storage organelle.			16
Unit -II	Chloroplast: Structure, Genome organization, Gene expression, RNA editing, Nucleochloroplastic interaction. Mitochondria: Structure, Genome organization, Biogenesis. Other cellular organelles: Structure & functions of Microbodies, Golgi apparatus, Lysosomes, Endoplasmic reticulum			12
Unit-III	Nucleus: Structure, Nuclear pores, Nucleosome organization, Replication, Damage & repair. Transcription: Plant promoters & transcription factors, Splicing, m-RNA transport, Nucleolus, tRNA, Micro-RNA.			8
Unit-IV	Ribosomes: Structure, Site of protein synthesis, Mechanism of translation initiation, Elongation & termination. Stability of proteins, Conformation of proteins (Ramachandran plot, Secondary structure, Domains, Motif and folds). *Protein sorting*: Targeting of proteins to organelles, Mechanism of sorting and regulation of target transport.			12

References: Book

1. Molecular Biology of the Cell by B. Albert, D. Bary, J. Lewis, M. Raff, K. Roberts and J.D. Watson.
2. Molecular Cell Biology by J. Damell, H. Lodish and D. Baltimore
3. Cytogenetics by P.K. Gupta
4. Molecular Cell Biology by H.Lodish, A. Berk, S.L. Zipurskt, P. Matsudaire, D . Baltimore and W.H. Darnell.

Sub Code	Subject Name	Credit	Int. Marks	Ext. Marks
BOT-413	Plant Biochemistry	4	10	40

Objective	The objective of this paper is to comprehend different concepts related to plant biochemistry. To understand the properties and significance of different biomolecules like carbohydrates, lipids, proteins & nucleic acids. To study the concept of Enzymology along with regulation of enzyme activity and mechanism of action.
Pre-Requisites	Basic knowledge of different biomolecules present in plants
Teaching Scheme	Regular class room lectures, seminars, tutorials and group discussions encouraging interactive sessions between student and teacher, practical classes helping students to clear their understanding of the concepts.

Detailed Syllabus		
Unit	**Topic**	**Hours**
I	Amino acids: Classification and properties, Acid–base properties, The Peptide bond, ionizationbehaviour of peptides, biologically active peptides. Levels of protein structure, Determination of primary structure of protein. Three dimensional structure of proteins (Secondary, tertiary and quaternary structures, structural patterns: motifs and domains), Protein denaturation and folding, Amino acid catabolism (transamination, oxidative deamination and urea cycle), Protein degradation (proteosomal pathway) and Solid phase synthesis of peptides.	12
II	Carbohydrates: Classification, configuration and conformation of monosaccharides, sugar derivatives, important disaccharides. Structural and storage polysaccharides, glucosaminoglycans,proteoglycans, glycoproteins and glycolipids Carbohydrate metabolism: Glycolysis, TCA cycle, pentose-phosphate pathway. Gluconeogenesis, glycogen metabolism, regulation of carbohydrate metabolism, Oxidative phosphorylation, electrontransport and ATP synthesis.	12
III	Enzymes: General properties, nomenclature and classification, extraction and assay Michaelis-Menten kinetics and its significance, Brigg's-Halden modification, determination of VmaxandKmMechanism of enzyme action: general acid-base catalysis, covalent catalysis, metal catalysis. Mechanism of action of RNAse, Lysozyme and Chymotrypsin Enzyme inhibition: competitive, non-competitive inhibition,determination of Ki, allosteric regulation, covalent modification.	12
IV	Nucleic Acid: Structure of Nucleic acids, DNA structure, A, B & Z forms, Lipids: Classification, storage lipids, structural lipids (glycerophospholipid and sphingolipids), signalling lipids, cofactors, terpenes, and pigments. Coenzymes and vitamins Biosynthesis and oxidation of fatty acids, regulation of fatty acid metabolism.	12
	Total	48

Text books: Lehninger's Principles of Biochemistry by D. Nelson and M. Cox

Sub Code	Subject Name	Credit	Int. Marks	Ext. Marks
BOT-414	Instrumentation, Biostatistics and Computer application	4	10	40
Objective	The objective of this paper is to introduce the concept of application and significance of different sophisticated techniques involving high end technology, computer programs and statistical methods to solve various plant biology related problems.			
Pre-Requisites	Basic knowledge of computer and physics of higher secondary level.			
Teaching Scheme	Regular class room lectures using ICT tools as and when required, computer classes, problem solving sessions, group discussions encouraging interactive sessions between student and teacher, practical classes to understand the handling and working of different instruments used in the study of plant biology			

Detailed Syllabus		
Unit	**Topic**	**Hours**
I	Principle of operation and Instrumentation of Light, Fluorescence and Electron MicroscopesUltraviolet-visible absorption spectroscopy: Principle, Instrumentation and application, Fluorescence spectrophotometry: Principle, Instrumentation and application. Radioisotope techniques: Nature of radioactivity, isotopes in biochemistry, measurement of radioactivity (carbon dating, Geiger-Muller counting and liquid scintillation counting).	12
II	Principles of electrochemical techniques: Electrochemical cells and reactions, potentiometry and voltametry, the pH electrode. Centrifugation techniques: Basic principles of sedimentation, Types of centrifuges, Types of rotors, Methods in preparatory ultracentrifugation (differential and density gradient centrifugation).Chromatographic techniques: Principles of chromatography (Adsorption and Partition chromatography), Planar chromatography (Paper and Thin-layer chromatography), Column chromatography (Gas chromatography, Gel exclusion/permeation chromatography, Ion exchange chromatography, Affinity chromatography, HPLC).	12
III	Electrophoretic techniques: General principles, support media, electrophoresis of proteins (SDS-PAGE, native gels, gradient gels, isoelectric focusing gels and two dimensional gels), electrophoresis of nucleic acids (Agarose, pulse-field and sequencing gels). Blotting techniques (Southern, northern and western blotting).	12
IV	Statistical Methods: Sampling methods, sampling distribution, measures of central tendencyanddispersion, Probability distribution: normal, binominal and poisson distribution. Sample homogeneity and heterogeneity analysis by binomial and poisson distribution, Parametric and nonparametric statistics: paired and unpaired t-test and $\chi 2$ test, analysis of variance: one factor and two factor ANOVA, linear and non-linear regression and correlation.	12
	Total	48

Text books:1. Introduction to instrumentation in life sciences, by Anjana Sharma, Prakash Singh2.Introduction to Practical Biostatistics by B.N. Misra& M.K. Misra.

PaperBOT 415: Practical relating to BOT-411, BOT-412, BOT-413, BOT-414

- General idea on instruments used in microbiology laboratory
- Preparation and sterilization of media (Nutrient Agar, Nutrient Broth, Czapeck-Dox), Plating, Tubing, Slanting of media
- Gram staining and acid-fast staining of bacteria
- Isolation of bacteria in pure culture
- Study of commonly occurring cyanobacteria
- Measurement of length/breadth/diameter of microbial cell/spore using ocular and stage micrometer
- Study of principles of spectrophotometer and verification of Beer-Lambert's law
- Effect of substrate concentration on activity of any enzyme and determination of Km value. (Acid Phosphatase, peroxidase, catalase)
- Extraction of pigment from leaves and preparation of absorption spectra for chlorophylls and carotenoids
- Preparation of standard curves for quantification of protein, carbohydrate and reducing sugar
- Quantification of soluble and total protein and total carbohydrate contents of plant samples
- Isolation of Chloroplast and study of protein profile of RUBISCO by SDS-PAGE
- Practical related to Biostatistics and computer application
- Study of micro and macro algae in the field and in the laboratory (preparation of temporary and permanent materials and identification).
- Study of morphology and reproductive structures of algae belonging to different classes through permanent microscopic preparations and preserved specimens.
- Measurement of Dispersion, [Standard Deviation (SD), Standard Error of Mean (SEM), Variance] of the given plant sample
- Statistical analysis of biological samples and study of test of significance by t-test, $\chi 2$ test, and F-test
- Isolation of plant DNA and quantification of extracted DNA by spectrophotometric method.
- Separation of DNA by gel electrophoresis.

2nd Semester

Subject Code	Subject Name	Credit	Int. Mark	Ext. Mark
BOT-421	Plant Diversity- II	4	10	40

Objective	Main objective of this course is to know the characters and evolution of different major plant groups, such as bryophytes, pteridophytes and gymnosperms.
Pre-Requisites	Basic knowledge about phanerogams and cryptogams
Teaching Scheme	Regular classroom teaching with practical demonstration through field visits

Detailed Syllabus

Unit	Topics	Hours
I	Origin, Evolution and classification of Bryophytes, Ecological significance of Bryophytes, Structure and reproduction of Anthocerotales, Marchantiales, Metzgeriales,Jungermanniales, Sphagnales, Funariales and Polytrichales, Progressive sterilization of sporogenous tissues, Evolution of Gametophytes in Bryophytes.	12
II	Origin, Evolution and classification of Pteridophytes, General account of Psilophytales, Fossil Lycophytes, Sphenophytes, Fossil ferns. Stellar Evolution. Origin of Heterospory, Heterospory and seed habit.	10
III	Structure, Reproduction and Evolution of Psilopsida, Lycopsida, Sphenopsida and Pteropsida, Soral evolution, Origin, Morphology and Evolutionary significance of Sporocarp.	12
IV	Evolution and classification of Gymnosperms, Geological time scale, Fossilization process, General account of Pteridospermales, Cycadeoidales, Pentoxyllales, Fossil Ginkgoales, Cordaitales and fossil Coniferales. Structure and Reproduction of Cycadales, Ginkgoales, ConiferalesandGnetales. Complexities and Gametophytes in Gymnosperm, Evolution of female Gametophytes.	14
	Total	48

Text Books:

1. Bryophyta by B.R. Vashistha, A.K. Sinha and A. Kumar
2. Textbook of Bryophyta by AfrozAlam
3. Pteridophyta by B.R. Vashistha
4. Gymnosperms Structure & Evolution by C.J. Chamberlain
5. The Gymnosperms by C. Biswas & B.M. Johri

Sub Code	Subject Name	Credit	Int. Marks	Ext. Marks
BOT-422	Genetics and Plant Breeding	4	10	40

Objective	The basic objective of this paper is to introduce the students to the concept of genetics including principles governing Mendelian inheritance, gene interactions and gene expression at molecular, cellular and organism level to help students develop quantitative problem solving skills to genetic problems
Pre-Requisites	Knowledge of genes, chromosomes, eukaryotic cell cycle and mitotic and meiotic cell cycle
Teaching Scheme	Regular class room lectures, seminars, tutorials and group discussions encouraging interactive sessions between student and teacher, solving problems relating to different aspects of genetics, practical classes helping students to clear their understanding of the basic concepts of genetics

Detailed Syllabus

Unit	Topic	Hours
I	Mendel's experiments and laws of inheritance, gene interaction with epistasis or modified mendelian dihybrid ratios: masking gene action, supplementary gene action, duplicate gene action, complementary gene action, self incompatibility in plants; Polygenic inheritance, Maternal effects and cytoplasmic inheritance, mitochondrial & chloroplast genome.	8
II	Sex chromosomes, Chromosomal sex determination: XX-XY, XX-XO and ZZ-ZW systems, Compound sex chromosome, Meiotic behavior of chromosomes: Primary & Secondary non-disjunction, Genic balance theory of sex determination, Sex influenced dominance by sex-linked gene expression. Sex determination in plants.Population genetics: Hardy-Weinberg's Law, genetics of quantitative traits in population.	14
III	Linkage groups: Complete and incomplete linkage. Crossing over: Relationship between genetic and cytological crossing over, Relationship between crossing over and chaisma formation, molecular mechanism of crossing over. Detection of linkage& Linkage maps: Test cross, test for linkage on the basis of F2 generation, LOD score, gene mapping, three point test cross in Drosophila, construction of linkage maps, identification of particular linkage groups with specific chromosome, physical distance and map distance Interference and coincidence, Mitotic Recombination, Recombination within gene.	14
IV	Structural and numerical alterations in chromosomes: Spontaneous and induced mutations, physical and chemical mutagens, chromosomal aberrations, meiotic behavior of deletion, duplication, inversion and translocation. Euploids and aneuploids-classification, origin, induction, role of polyploidy in evolution and practical significance in crop improvement. Plant Breeding: Method of plant breeding – introduction & selection (Pedegree, back cross, mass selection, bulk method), Male sterility and Heterosis breeding, Mutation breeding.	12
	Total	48

Text books: Genetics by M. W. Strickberger

Sub Code	Subject Name	Credit	Int. mark	Ext. Mark
BOT-423	**Plant Biotechnology and Tissue culture**	4	10	40
Objectives	The basic objective of the course is to introduce the students mind regarding applied areas of biology in commercial scale through crop improvement and year round basis of seedlings and agriproducts			
Prerequisites	Ideas on applied areas of Plant sciences and Crop improvement			
Teaching Scheme	Class room lectures with use of ICT and Practical's of Tissue culture, PCR and other biotechnological tools			
	Detailed Syllabus			
Unit -I	Plant cell, Tissue & organ culture: History, Scope and concept of cellular differentiations, Totipotency, Fundamental aspects of morphogenesis: organogenesis and somatic embryogenesis, Clonal propagation, Artificial seeds, Hybrids through embryo rescue. Androgenesis and production of haploids, Callus and cell suspension culture, Production of somaclonal variants, Production of secondary metabolites in cultures, Cryopreservation			15
Unit -II	Somatic hybridization and cybridization: Factors affecting Protoplast Isolation, Culture and plant regeneration, Protoplast fusion-chemical fusion & electrofusion mechanism & techniques, Selection of heterokaryotic fusion products, Biochemical selection and physical selection (micromanipulation, flow cytometric characterization and cell sorting), Analysis of hybrids, Somatic hybrids and Cybrids for Crop Improvement			15
Unit-III	Recombinant DNA technology: Gene cloning-principles, Cloning vectors-plasmids, Phages, Cosmids& phagemids; Artificial chromosomes, Polymerase Chain Reaction-principles, Types and applications, RT-PCR; Genomic and c DNA libraries; Construction of recombinant DNA molecules and their mobilization into bacteria; Analysis of recombinant clones, DNA sequencing.			10
Unit-IV	Genetic Engineering of plants: Methods for gene transfer to plants, *Agrobacterium* mediated and direct gene delivery, Gene tagging, Detection of foreign gene and gene products; Southern blotting, Northern blotting and Western blotting; Chloroplast transformation, Gene targeting, Transgenic plants for crop improvement, Intellectual property rights, Possible ecological risks and ethical concerns.			08

References: Book

1. Plant Biotechnology, the genetic manipulation of plants by A. Slater, N. Scott & M. Fowler
2. Plant Tissue Culture: Theory & Practice by S.S. Bhojwani& M.K. Razdan
3. Introduction to Plant Biotechnology by H.S. Chawla
4. Biotechnology by B. D. Singh

Subject Code	Subject Name	Credit	Int. Mark	Ext. Mark
BOT-424	Ecology and Environmental Biology	4	10	40

Objective	Main objective of this paper is to know,how the organisms interact with each other and their environment. Also, to understand the natureof environmental influences on individual organisms, their populations, andcommunities and ultimately at the level of the biosphere.
Pre-Requisites	Basic knowledge on biotic and abiotic components of ecosystems.
Teaching Scheme	Regular classroom teaching with practical through field visits

Detailed Syllabus

Unit	Topics	Hours
I	Abiotic and biotic components; Primary and secondary production, methods of measuring productivity, pattern of primary production and biomass in the major ecosystem of the world. Energy flow: food chain, food web and Ecological pyramid in terrestrial and aquatic ecosystems. Biogeochemical cycles - Carbon, Nitrogen, Sulphur, Phosphorus.	12
II	Community ecology: concept, structural analysis: Qualitative and Quantitative analysis of plant community. Ecological niche, Ecotone and edge effect. Competition theory and coexistence. Succession - models of succession(monoclimax and polyclimax theories), Mechanism of succession in natural communities - facilitation, tolerance, and inhibition.	12
III	Population ecology: Basic concept, population characters, biotic potential. Population growth: population growth curves, laws of population growth, regulation of population density, limiting factors of population growth, population fluctuation, r & k selection, Population interactions: positive and negative interactions, interspecific relationship. Population regulation: competitive exclusion, density dependent and independent regulation.	12
IV	Biodiversity status monitoring and documentation, Approaches for biodiversity management: *In-situ* and *Ex situ*conservation, Biosphere reserve. Environmental pollution: Kinds and sources of pollutants, classification of pollutants, Soil pollutants: sources, types, and effects; modification of plant productivity by soil pollution, effects on soil microflora. Water & Air pollutants: fates and effects, role of plants for pollution control, Global climate change, green house effect, ozone depletion- causes and effects.	12
	Total	48

Text Books:

1. Ecology by E.P Odum
2. Ecology and Environment by P.D. Sharma
3. Fundamentals of ecology by M.C. Dash
4. Biodiversity and Conservation by G. Melchias

Paper BOT-425: Practical relating to BOT-421, BOT-422, BOT-423, BOT-424

- Study of temporary & permanent preparation for microscope observation of external and internal features of vegetative and reproductive structure of important genera of Bryophytes
- Study of temporary and permanent preparation of vegetative and reproductive structure of Pteridophytes
- Study of temporary and permanent preparation of vegetative and reproductive structure of Gymnosperms
- Squashing techniques for study of mitosis and meiosis in onion root tip and flower bud. Use of camera lucida to study chromosomes & calculating the magnification
- To find out mitotic index of dividing cells of Allium cepa root tips
- Comparative karyotypic analysis of two species of a genus
- Preparation of tissue culture media
- Techniques of surface sterilization and plant regeneration via organ culture
- Study of plant communities by Quadrat method and determine Frequency, Density and Abundance.
- To determine the minimum size of the Quadrat by species area curve method.
- Isolation of plant DNA and quantification of extracted DNA by spectrophotometric method.
- Separation of DNA by gel electrophoresis.

3rd Semester

Subject Code	Subject Name	Credit	Int. Mark	Ext. Mark
BOT-531	Plant Systematic & Economic Biology	4	10	40

Objective	Major objectives of this paper are to understand scientific naming of Plants, classification of plants on the basis of their evolutionary history and molecular studies, learning the floral structure of important plant families and economic importance of plants.
Pre-Requisites	Basic knowledge about different plant parts and terminology.
Teaching Scheme	Regular classroom teaching with practical demonstration with local flora.

Detailed Syllabus

Unit	Topics	Hours
I	Nomenclature: The species concept, Salient features ICN (Typification, Author citation, Valid publication, Rejection of names, Principle of priority and its limitation). Herbarium Methodology and important herbaria of the World. Phenetic and Phylogenetic systems of classification, relative merits and demerits of major system ofclassification (Benthem& Hooker, Engler-Prantl, Hutchinson, Takhtajan, APG system)	14
II	Cladistics in taxonomy: concepts and methodology, parallelism and convergence, cladistics in classification of plants. Molecular taxonomy, Morphology, anatomy, palyonology, embryology, cytology and phytochemistry as taxonomic tools.	10
III	Plant families:Phylogeny of flowering plants. Range of floral structures in major dicot groups: Ranales, Rosales, Asterales and Lamiales,Range of floral structures in monocot groups: Poales, Scitaminae and Orchidales.	12
IV	Economic Biology: Origin and domestication of cultivated plants, World centres of diversity of domesticated plants, Plant introduction and secondary centre origin, Plants used as food, Forage, Fodder, Fibre and oil-yielding crops. Uses of medicinal and aromatic plants, Important firewood and timber yielding plants and nonwood forest products, Plants used as avenue trees for shade, pollution control and aesthetics.	12
	Total	48

Text Books:

1. Current concepts in plant taxonomy by V.H. Heywood and D. N. Moore.
2. Taxonomy of Angiosperms by AVSS Sambamurthy
3. Economic Botany by A.F. Hill.
4. Economic Botany by H.P. Pandey.

Sub Code	Subject Name	Credit	Int. Marks	Ext. Marks
BOT-532	Plant Physiology	4	10	40

Objective	The basic objective of this paper is to elaborate on the various physiological processes occurring in the plants. To help the students to understand the water relation of plants with respect to various physiological processes, to explain the significance of photosynthesis and nitrogen metabolism in plants. To introduce the concept of stress physiology in plants
Pre-Requisites	Knowledge of anatomical and cellular organisation of plants
Teaching Scheme	Regular class room lectures, seminars, tutorials and group discussions encouraging interactive sessions between student and teacher, practical classes helping students to clear their understanding of the basic concepts of plant physiology

Detailed Syllabus		
Unit	**Topic**	**Hours**
I	Water balance in plants, water absorption and transport through xylem, active and passive transport, Transport of ions across membrane barrier, membrane transport processes, Membrane transport proteins: water channels, H+ - ATPase and H+-pyrophosphatase, Mechanism of solute accumulation in vacuoles, solute transport: Phloem loading & unloading	12
II	Photochemistry and photosynthesis: General concept of photochemistry, Photosynthetic pigments and light harvesting complexes, Photo-oxidation of water, mechanisms of electron and proton transport & ATP synthesis. Carbon assimilation: C3, C4 cycle and the CAM pathway photorespiration & its significance, the glyoxylate cycle Biosynthesis of starch and sucrose	12
III	Nitrogen metabolism: Overview, biological nitrogen fixation, mechanism of nitrate uptake and reduction, nitrate and ammonium assimilation, amino acid biosynthesis. Stress Physiology: Responses of plants to biotic and abiotic stresses, mechanism of stress resistance and tolerance, water deficit and drought stress, salinity stress, metal toxicity, freezing and heat stress, HR and SAR, oxidative stress.	14
IV	Plant growth regulators: Physiological effects and mechanism of action of auxins, gibberellins, cytokinins, ethylene and abscisic acid Photoreceptors: phytochromes, cryptochromes, phototropin, UV-B and their role in regulation of plant morphogenesis. Flowering: Phenomenon of flowering, photoperiodism and its significance, endogenous clock	10
	Total	48

Text books: Plant Physiology by L. Taiz, and E. Zeiger,

Sub Code	Subject Name	Credit	Int. mark	Ext. Mark
BOT-533	**Plant Anatomy and Developmental Botany**	4	10	40
Objectives	The basic objective of the course is to study the anatomical feature of shoot ,root leaf flower and fruits with emphasizing their developmental feature and variations for production of mutant seedlings and their mechanistic approach			
Prerequisites	To Understand the anatomical feature with regard to developmental process			
Teaching Scheme	Class room lectures with use of ICT and Practical's of anatomy and developmental process			
	Detailed Syllabus			
Unit -I	Differentiation and Development: Difference between animal and plant cell development with unique features in plant cell development, Use of mutants in seedling development; Molecular analysis of shoot apical meristem; Root apical meristem & leaf growth, Leaf development and phyllotaxy, Transition to flowering, Vascular tissue differentiation of root, Shoot & leaf, Floral development & homoeotic mutants in *Arabidopsis* &*Antirrhinum.*			15
Unit -II	Developmental Biology: Molecular and cytological analysis of endosperm & fruit development, Fruit ripening and its manipulation; Polyembryony, Apomixes, Seed germination; Seed dormancy, Bud dormancy, Types & programmed cell death in life cycle of plants, Metabolic changes associated with senescence and its regulation. Influence of hormones & environmental factors on senescence.			15
Unit-III	Male gametophyte: Structure of anthers, Microsporogenesis, Role of tapetum, Pollen development, Male sterility, Male nuclei dimorphism and hybrid seed production, Pollen germination, Pollen tube growth and guidance, pollen storage, Pollen allergy, Pollen embryos.			10
Unit-IV	Female gametophyte: Ovule development, Megasporogenesis, Organization of the embryo sac, Structure of the embryo sac cells, Floral characteristics, Pollination mechanisms and vectors, Breeding systems, Structure of pistil. Developmental Embryology: Pollen-stigma interactions, Sporophytic and gametophytic self incompatibility (cytological, biochemical and molecular aspects), Double fertilization, in vitro fertilization.			08

References: Book

1. The Embryology of Angiosperms by S.S. Bhojwaniand S.P. Bhatnagar
2. An Introduction to Plant Structure and Development by Beck,
3. Mechanisms in Plant Development by Ottoline Leyser and Stephen Day
4. Plant Anatomy by Esau.

Subject Code	Subject Name	Credit	Int. Mark	Ext. Mark
BOT-534	CBCS (Choice Based Credit System)	4	10	40

Objective	The main objective of this course is to provide basic knowledge about major plant groups, plant cell structure & function and different physiological processes inside the plant cell.
Pre-Requisites	Sound knowledge on plant kingdom
Teaching Scheme	Regular classroom lectures with visual information.

Detailed Syllabus

Unit	Topics	Hours
I	Five kingdom classification and salient features of Monera, Protista and Fungi, Lichens, Viruses and Viroids, General Characteristics & Classification of plants into major groups Algae, Fungi, Bryophyte, Pteridophyte & Gymnosperms and their economic importance.	12
II	Characteristics of prokaryotic & eukaryotic cells, Structure & Function of plant cell & its cell organelles: Cell Wall, Cell Membrane, Cytoplasm, Nucleus, Chloroplast, Mitochondria, Endoplasmic Reticulum, Vacuoles, Lysosomes, Golgi bodies.	12
III	Morphology of Angiosperms: Roots, Stem & Leaf; Flower development; Different tissue organisation (Simple & Complex tissue).	10
IV	Photosynthesis: light & dark reaction; Respiration: Glycolysis, Krebs cycle, ATP generation; Plant growth regulators: Auxin, Gibberellic Acid, Cytokinins, Abscisic acid, Ethylene: Synthesis & their function.	14
	Total	48

Text Books:

1. College Botany by B.P. Pandey. Publisher: S Chand
2. Fundamentals of Plant Physiology by V K Jain. Publisher: S Chand
3. Microbiology by P D Sharma. Publisher: Rastogi Publications
4. Plant Morphology by S Sharan. Publlisher: Pacific Books International

Paper BOT- 535: Practical relating to BOT-531, BOT-532, BOT-533, BOT-534

- Collection, description and identification of locally available wild angiospermic taxa pertaining to nomenclaturally important category
- Preparation of herbarium specimens of locally available angiosperm
- Morphological description of dicot and monocot plants and identification by using Flora book
- Description of various species of a genus and preparation of a key at generic level
- Study of living shoots apices by dissection using Hydrilla plants
- Study of cytological zonation in the shoot apical meristem (SAM) by preparing L. S of *Coleus* shoot apex and making permanent slides with double stained procedures
- Study of wood anatomy through temporary slides
- Study of different types of ovules, endosperm, and embryos
- To estimate dissolved oxygen and CO_2 in eutrophic and oligotrophic water samples
- Determination of acidity and alkalinity content of different water sample
- To study the arrangement and distribution of stomata in isobilateral and dorsi ventral leaves and measurement of stomatal density
- Separation of plant pigments (chlorophyll) by chromatography.
- Preparation of a short list of ten most important sources of firewood and timber of the locality. Give their local names, scientific names and families to which they belong. Mention their characters
- Study of biodiversity and important flora of Odisha and India through field trips

4th Semester

ELECTIVE – I(PHYSIOLOGY)

BOT – 541 (PHYSIOLOGY I)

Sub Code	Subject Name	Credit	Int. mark	Ext. Mark
BOT-541	**PHYSIOLOGY I**	4	10	40
Objectives	The basic objective of the course is to study the life process of plant and their physiological and biochemical phenomenon including factors which have direct and indirect effect on plant growth and development.			
Prerequisites	To Understand the plant life process and effect of internal and external factors			
Teaching Scheme	Class room lectures with use of ICT and Practical's of physiology and Biochemistry			
	Detailed Syllabus			
Unit -I	Plant Water relations: Physical properties of water, Importance of water to plant life. Diffusion, imbibition and osmosis, concept & components of Water potential. Absorption and transport of water and ascent of sap. Transpiration: Definition, types of transpiration, structure and opening and closing mechanism of stomata.			15
Unit -II	Mineral nutrition & Solute Transport: Essential elements (macro and micronutrients) and their role in plant metabolism, deficiency symptoms. Mineral uptake and Solute transport through plasma membrane, Role of aquaporins, channel protein, carrier protein and pumps in active and passive transport.			15
Unit-III	Photosynthesis: Photochemistry, Photosynthetic pigments, photosynthetic light reactions, photo- phosphorylation, carbon assimilation pathways: C_3, C_4, and CAM, Photorespiration and its significance. Translocation of organic solutes: mechanism of phloem transport, source-sink relationships.			10
Unit-IV	Respiration: Glycolysis, anaerobic respiration, TCA cycle, electron transport system. Mechanism of oxidative phosphorylation. Lipid Metabolism: Types of lipids, alpha and beta-oxidation of fatty acids.			08

References: Book

1. Plant Physiology by Salisbury F.B. and Ross C.W.,
2. Plant Physiology, L. Taiz, and E. Zeiger,
3. Introductory Plant Physiology by C.R Noogie and G.J.Fritz.
4. Introduction to Plant Physiology by W.G. Hopkins.
5. Life Processes in Plants by A. W. Galston.

Sub Code	Subject Name	Credit	Int. Marks	Ext. Marks
BOT-542	Elective I- (Plant Physiology)	4	10	40

Objective	The objective of this paper is to know the importance and scope of plant physiology. To understand the concept of cell signaling in plants to co-ordinate their activities in response to changing conditions that guide plants cycle of growth, flowering and fruiting. To enhance the knowledge of plants response to pathogens at structural, biochemical and molecular level.
Pre-Requisites	Basic knowledge of plant physiology
Teaching Scheme	Regular class room lectures, seminars, tutorials and group discussions encouraging interactive sessions between student and teacher, weekly projects, practical classes helping students to clear their understanding of the concepts.

Detailed Syllabus		
Unit	**Topic**	**Hours**
I	Nitrogen metabolism- Symbiotic and asymbiotic N_2 fixation in plants, Molecular mechanism of nitrogen uptake, Role of nitrogenase enzyme complex, Nod factors, Nif genes, leghaemoglobin: structure & function, Nitrate uptake and reduction in plants. Biosynthesis of aminoacids.	10
II	Growth and development: Definition, phases and kinetics of growth. Biosynthesis and Physiological effects of phytohormones - Auxins, Gibberellins, Cytokinins, ABA, Ethylene and Brassinosteroids. Physiology of flowering -photoperiodism, role of phytochrome in flowering; Vernalization. Physiology of Scenescence and Ageing.	10
III	General aspects, Seed germination and seedling growth, shoot, leaf and root development, Floral induction and Development, Senescence and Programmed Cell Death (PCD), Signal Transduction-Basic concepts, Receptors and G-proteins, Cyclic AMP cascade, Phospholipid and Ca2+ calmodulin cascade, MAP kinase cascade (second messenger), Two component sensor regulator system, sucrose sensing and mechanism, Signaling molecules, Environmental stimuli, Cellular responses, Types of receptor, Major pathway examples, Molecular mechanism of hormone action, Role of mutants in understanding hormone action, Molecular mechanism of light perception, signal transduction and gene regulation. Biological clocks and their genetic and molecular determinants	14
IV	Introduction to plant pathology, survival of plant pathogens, dispersal of plant pathogens, phenomenon of infection process: biochemical and molecular, R protein, Avrprotein,R gene mediated resistance, Phytoalexins,Plantibodies, Role of enzymes in pathogenesis, Role of growth regulators in plant pathogenesis, Defense mechanism in plants, Plant disease epidemiology, Principles of plant disease management	14
	Total	48

Text books: Plant Physiology by L. Taiz, and E. Zeiger,

Introduction to Plant Physiology by W.G. Hopkins

BOT – 543 (Physiology Practical related to Paper BOT-541, 542)

1. To determine the osmotic pressure of vascular sap of Rhoeo-discolor/ Tradescantia leaves by plasmolytic method.
2. To determine the Diffusion Pressure Deficit (water potential) of potato tuber by weighing method/Density method.
3. To measure the rate of photosynthesis in leaves.
4. To determine the chlorophyll a / chlorophyll b ratio in C3 and C4 plants.
5. To estimate the percentage of total reducing sugar in a plant.
6. To measure the rate of respiration in germinating seedling.
7. Qualitative tests of different Phytochemicals using plant sample.
8. Estimation of free acids in Bryophyllum.
9. Determination of Q10 (Temperature coefficient) of photosynthesis (light reaction).
10. To study the effect of cold treatment /scarification on breaking dormancy.
11. To study the effects of light (Phytochrome) kinetin on seed germination
12. Bioassay for quantitative estimation of Auxin in coleoptiles tips

ELECTIVE – II (BIOSYSTEMATICS)

Subject Code	Subject Name	Credit	Int. Mark	Ext. Mark
BOT-541	BIOSYSTEMATICS-I	4	10	40

Objective	The major objectives of this paper are to acquire depth knowledge about classification and nomenclature of plants, floristic inventory, herbarium techniques and taxonomy of cultivated plants.
Pre-Requisites	Basic knowledge about Plant taxonomy
Teaching Scheme	Regular classroom teaching with localplant identification in laboratory and field.

Detailed Syllabus

Unit	Topics	Hours
I	Synthetic Plant Classification: Characters of taxonomic significance, morphological, anatomical, embryological, palynological and cytological data for developing synthetic approach to classification.	12
II	Plant Nomenclature: Development of ICN, Determination of types and typification. Orthography of names and Epithetes. Principles of priority and its limitation. Names of Hybrids.	12
III	Floristic Survey: Field collection and preservation of specimens. Phytogeography, assessment of threatened species. Analysis of flora of Odisha. Documentation on data. Mangroves of Odisha, significance and conservation.	12
IV	Herbarium management: Concept, historical development. Role of Herbarium, Preservation of specimens and maintenance. Taxonomy of cultivated plants: Centres of diversity and Centres of origin. Exploration and collection of plant genetic resources. Establishment of gene bank. Cryopreservation.	12
	Total	48

ELECTIVE – II (BIOSYSTEMATICS)

Subject Code	Subject Name	Credit	Int. Mark	Ext. Mark
BOT-542	BIOSYSTEMATICS-II	4	10	40

Objective	The primary objective of this paper is to acquire depth knowledge about classification of plants on the basis of chemical compounds present inside plants, their molecular biology and distribution pattern of plants on earth. The secondary objective of this paper is to familiar with botanical publications, collections and documentation of taxonomic characters.
Pre-Requisites	Basic knowledge about Plant taxonomy
Teaching Scheme	Regular classroom teaching with practical demonstration in laboratory.

Detailed Syllabus

Unit	Topics	Hours
I	Chemotaxonomy: compounds useful in Plant Taxonomy. Primary and secondary metabolites. Semantides. Stages of chemotaxonomic investigation. Genetic techniques in systematics: Genetic analysis of characters and phonetic variation. Dominance, epistasis, pleotropy. Application of DNA hybridization technique in taxonomy.	12
II	Molecular Taxonomy: Application of Molecular markers, Isozyme, RAPD, AFLP, RFLP for phylogeny and establishment of genomic relationship. Resolving taxonomic problems using molecular tools. Assessment of genetic diversity.	12
III	Phytogeography and Taxonomy: Taxonomic information from plant geography and ecology. Patterns of phytogeography. Disjunction. Variance. Endemism,Ecotypification, alien species, phenotypic plasticity.	12
IV	Taxonomic literature: Floras, Monographs and Revisions. Keys: Single access and Multi-access. Use of computers in Taxonomy, collecting and converting data.	12
	Total	48

Text Books:

1. Current concepts in plant taxonomy by V.H. Heywood and D. N. Moore.
2. Taxonomy of Angiosperms by AVSS Sambamurthy
3. Plant Taxonomy by O.P. Sharma

   Vascular Plant Taxonomy by Dirk R. Walters

BOT – 543 (Biosystematics Practical related to Paper BOT-541, 542)

1. Description of a specimen from representative and locally available families.
2. Description of a species based on various specimens to study intraspecific variation: A collective exercise.
3. Description of various species of a genus: Location of key character and preparation of keys at genetic level.
4. Location of key characters and use of keys at family level.
5. Exercises on nomenclature problems: Author citation, Principle of priority and Transfer of taxa.
6. Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants wild or cultivated, as are abundant.
7. Comparative study of the pollen grains, fruit and seed morphology.
8. Study of different types of ovules, placentation and evolutionary trends therein
9. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
10. Training in using floras and herbaria for identification of specimens.

Paper BOT- 544: Dissertation