M.Sc. BOTANY
2 YEARS SEMESTER COURSE

(2023-25)

COURSES OF STUDY
(CHOICE BASED CREDIT SYSTEM)

P.G. DEPARTMENT OF BOTANY
SHAILABALA WOMEN'S AUTONOMOUS COLLEGE
CUTTACK, ODISHA

Syllabus for M.Sc. Botany
(2023-2025 session)

Basic Program Information

Department	:	Department of Botany, Shailabala Women's (Auto) College
Title of the program	:	Master of Science
Degree(s) to be offered	:	Master of Science in Botany(Specialization)
Implementation from	:	2023
Eligibility Criteria	:	Any Biological Science graduate having Botany as Hons./Core Subject with at least 45% of marks in aggregate.
Selection Criteria	:	Odisha Common PG Entrance Test (CPET)
Duration of Course	:	2Years (4Semesters)
Number of Seats	:	16

Vision:

- The Department of Botany strives to be recognized as a responsive center of higher learning and promoting research through excellence, fellowship, inclusiveness, and professional and community development in the process of realizing the goals set forth and for providing specialized education to students after their +3 level of education.
- To create botany professionals who are leaders in entrepreneurship, creativity, innovation, and technology.

Mission:

- To build a research-based education model in Botany.
- To provide advanced theoretical and practical training in Botany with a specific specialty.
- To provide state-of-the-art outcome-based teaching/learning approaches.

Scientific-Socio-Economic Relevance:

The graduate students will develop into self-sufficient, critical scientists. Masters of Botany will provide the necessary expertise to compete in tough national or worldwide PhD programs. Additionally, the learned research techniques will equip the student to work as a scientist in any career path.

Curriculum designed with a broad knowledge base:

The Department inculcates students with the contemporary skills necessary to meet the demands of industry, academia, government, and non-governmental organizations. The curriculum has been developed with a comprehensive knowledge basis, covering courses from the fundamental sciences (biology, mathematics, chemistry), as well as advanced courses in biotechnology, keeping in mind the multidisciplinary aspect of Botany. In order to make the students internationally competitive, the curriculum has been specifically created to contain the recommended syllabus of CSIR, GATE, ICMR and ASRB. Project-based learning is a crucial component of curriculum.

Employment opportunities:

Students who major in botany will be better prepared to enter the teaching profession, plant taxonomy, scientific research, biotechnology, bioinformatics or the pharmaceutical sector. The demanding project work allows industry to employ more thinkers and planners who have the knowledge, skills, and insight to recognize a problem and develop the necessary strategy to address it. Due to their maturity and technical proficiency, M.Sc. graduates are highly valued by the industry.

Skill based study:

The department offers a skill based noncredit course which enables the students to build knowledge by developing practical expertise in a particular area.

Advantages or Benefits of Master of Science Degree (*Ways in which the program will meet the needs of society)*:

The programme seeks to prepare life scientists for employment in research organisations or commercial settings. Students who successfully complete the programme will acquire following skills:

- thorough knowledge of Botany in general as well as more in-depth knowledge of at least one specified area.

- the capacity to make wise decisions based on recent research.
- the capacity to discover novel insights and results and to create novel methodologies.
- the capacity to structure and analyse issues in various contexts.
- a critical appreciation of the role that Botany plays in society.
- the capacity to solve biological problems using the most appropriate experimental and/or theoretical approaches and to report on research findings.
- the comprehensive development of a graduate student's life

Curriculum structure: Syllabus has the following parts.

1. Hard Core (HC)
2. Core Elective/Specialization (CE)
3. Allied Core (AC)
4. Open Elective (OE)
5. Field Internship/Field Trip Report (Fl)

Examination Pattern:
Theory: (for 5 credit courses)

A. Mid-Term Exam: 30 marks, 20 marks (Internal) +10 (assignment)
B. End-Term Exam: 70 marks
Total: 100 marks
Mid-Term Exam: Duration-1 Hour
End-Term Exam: Duration-3 Hours

Practical:
A. Mid-Term Exam: 30 marks ,20 marks (Internal) +10 (assignment)
B. End-Term Exam: 70 marks (Experiment/Written-50; Record-10; Viva Voce-10)
Total: 100 marks

Mid-Term Exam: Duration-3 Hours: End-Term Exam: Duration-6 Hours

OUTLINE COURSE STRUCTURE MSc. (Botany) SYLLABUS

PAPER	COURSE CODE	COURSE TITLE	UNIT	CREDITS	MID-SEM	END SEM.	TOTAL
		SEMESTER-I					
Hard Core	HC-101	Microbiology and Biotechniques	05	05	20+10	70	100
Hard Core	HC-102	Plant diversity	05	05	20+10	70	100
Hard Core	HC-103	Cell and Molecular biology	05	05	20+10	70	100
Hard Core	HC-104	Practical related to paper HC-101,HC-102,HC-103	-	05	20+10	70	100
Allied Core	AC-101	Computer application course by e-learning centre	03	03	10(mid sem)+10(prac)=20marks	30	50
TOTAL				**23**	**135**	**315**	**450**
		SEMESTER-II					
Hard Core	HC-201	Plant Systematics and Anatomy	05	05	20+10	70	100
Hard Core	HC-202	Genetics and Plant breeding	05	05	20+10	70	100
Hard Core	HC-203	Plant Biochemistry	05	05	20+10	70	100
Hard Core	HC-204	Practical related to paper HC-201,HC-202, HC-203and CE-201 A/B	-	05	20+10	70	100
Core Elective	CE-201 A/B	A: Research methodology B: MOOCs (From SWAYAM NPTEL) etc.	05	05	20+10	70	100
Open Elective	OE-201 A/B	A: Environment and disaster management B:MOOCs (From SWAYAM NPTEL) etc.	-	04	-	50	50
TOTAL				**29**	**150**	400	550
		SEMESTER-III					
Hard Core	HC-301	Plant Physiology and development	05	05	20+10	70	100
Hard Core	HC-302	Plant biotechnology and resource utilization	05	05	20+10	70	100
Hard Core	HC-303	Practical related to paper HC-301,HC-302	-	05	20+10	70	100
Core Elective	CE-301 A/B	A. Biochemistry and molecular biology-I B. Microbial technology-I	05	05	20+10	70	100
Core Elective	CE-302 A/B	A. Biochemistry and molecular biology-II B. Microbial technology-II	05	05	20+10	70	100
Field	FI-301	Field Internship/field trip report		03		50	50

Internship							
TOTAL				**28**	**150**	**400**	**550**
	SEMESTER-IV						
Hard Core	HC-401	Ecology, Evolution And Reproduction	05	05	20+10	70	100
Hard Core	HC-402	Advanced Practical Related HC-401, CE-301 And CE-302	-	05	20+10	70	100
Hard Core	HC-403	Seminar	-	5	-	100	100
Core Elective	CE-401	Dissertation	-	5	-	100	100
Allied Core	AC-401	WomenAnd Society	03	03	15	35	50
TOTAL				**23**	**15**	**435**	**450**

Other Non-Credit Courses: *Skill Based Course* –Garden and Lawn Care

SUMMARY

HC-Hard Core	14X100	1400
CE- Core Elective	4x100	400
OE- Open Elective	1x50	50
AC-Allied Core	2x50	100
FI-Field internship	1x50	50
Total Marks		**2000**

	Credits	**Total marks**
Sem-I	23	450
Sem-II	29	550
Sem-III	28	550
Sem-IV	23	450
Total	**103**	**2000**

SEMESTER I

HC-101	MICROBIOLOGY AND BIOTECHNIQUES	5Credits	100 MARKS

Course Objectives:
The paper aims to understand the history and development of microbiology, broad classification of microbes, growth and maintenance of microorganisms, spectrometry and electrophoresis.

Unit I: Microbial world: History and development of microbiology, Bergy's Manual for classification of microbes. Major microbial groups of aerobic and anaerobic habitats, Basic ideas about Archaebacteria, Eubacteria, Rickettsia, Cyanobacteria, General features of Mycoplasma, Spirochaetes

Unit II:Bacteria and Virus: Cell structure of bacteria Genetic recombination in bacteria-Transduction, Transformation and Conjugation, Role of Plasmids, General features and classification of virus (Bacteriophage structure, replication and life cycle) TMV Structure and replication. General features of Viroids and Prions (SARS), Gene mapping in bacteria, Genetic recombination in bacteriophages and mapping of phage genome.

Unit III:Microbial culture and growth: Isolation, purification, growth and maintenance of microorganisms. Growth media and microbial culture methods. Maintenance and preservation of microbes.Batch, continuous and Synchronous culture, Factors regulating microbial growth.

UNIT –IV: Spectroscopy: Properties of Electromagnetic radiation; Beer Lambert's law, Extinction coefficient, Principle and Application of UV- Visible light spectroscopy, Atomic absorption and flame emission spectroscopic technique, Mass spectrometry, X-Ray diffraction, X-Ray crystallography, principle and biological application of IR and NMR.

UNIT -V: Electrophoretic techniques: General principles, Characterization of proteins and nucleic acids, AGE, PAGE,SDS-PAGE,Immuno-electrophoresis,Isoelectrofocussing,Capillary Electrophoresis, DNA and Protein sequencing.

Learning Outcome: The course will impart knowledge on major microbial groups of aerobic and anaerobic habitats, genetic recombination, culture and preservation of bacteria, principle of spectroscopy and electrophoretic techniques.

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HC-102	PLANT DIVERSITY	5Credits	100 MARKS

Course Objectives: The paper aims to understand the evolutionary diversification, morphology, reproduction of lower plant groups and present-day vascular plants as well as life cycle of extinct plants.

UNIT-I: Algae: Habitats (Terrestrial, Freshwater, Marine); Classification based on thallus organization, pigment, flagella, reserve food, reproductions and life-cycles. Silent features of Chlorophyta, Dinophyta, Phaeophyta and Rhodophyta.Economic importance, Algal bloom and toxins; seaweed cultivation

UNIT-II: Fungi: Classification, Thallus organization, Nutrition, Reproduction, General account of Zygomycotina, Ascomycotina, Basidiomycotina, Degeneration of sex in Fungi, heterothallism, heterokaryosis, fungal toxins and their mode of action, Economic Importance

UNIT-III: Bryophyta: Origin, evolution and classification of Bryophytes, Structure and Reproduction of Marchantiales, Anthocerotales, Jungermanniales and Sphagnales; Progressive Sterilization of Sporogenous Tissues, Evolution of gametophytes on Bryophytes.

UNIT-IV: Pteridophyta: Origin, Evolution and Classification of Pteridophytes, Stelar evolution, Origin of Heterospory, Heterospory and Seed Habit, Structure and Reproduction of Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

UNIT-V: Gymnosperm: Structure and Reproduction of Cycadales, Coniferales, Gnetalesand Ginkgoales,. Evolution of male and Female Gametophyte.

Paleobotany: Geological Time Scale, Fossils: Types, process of Fossilization, Role of Fossils in Evolution. Brief account Fossil Pteridophytes and Gymnosperms.

Course Outcome: This course will impart knowledge on diversity of different plant groups present. Students will learn on structure, distribution, reproduction, and evolutionary patterns among algae, fungi, bryophytes, pteridophytes and gymnosperms.

HC-103	CELL AND MOLECULAR BIOLOGY	5Credits	100 MARKS

Course Objectives: The paper aims to understand the cellular processes, structure and function of cell organelles. It will explain on various molecular mechanisms, and regulatory mechanism of cell cycle.

Unit-I: Cell Wall: Structure & functions; biogenesis; growth, **Plasma membrane**: Structure, models, electrical properties of membrane & functions; lipid rafts, membrane carbohydrates and their role, **Transport across the plasma membrane**- types of passive and active transport, ion

channels, membrane pumps, endo- and exocytosis, **Cell interactions**: Plasmodesmata (Structure, comparison with gap junctions), Cellular adhesions, junctions, **Plant Vacuole:** Tonoplast membrane; ATPases, transporters as storage organelle, **Cytoskeleton:** microtubules, intermediate filaments, microfilaments (structure and dynamics) motor movements, mechanism of cilia, flagella & other movements.

Unit-II: Cellular organelles: Chloroplast and mitochondria (Structure, genome organization, biogenesis, function), Structure & functions of endoplasmic reticulum, Golgi apparatus, peroxisomes, lysosomes.
Nucleus: Structure, nuclear transport and trafficking, chromatin structure, nucleosome organization and DNA packaging

Unit-III: Protein sorting and targeting: Overview of sorting mechanism to various organelles, signal sequences, targeting of proteins to mitochondria and chloroplast, Secretory pathway, Protein import into ER (Co- and post-translational translocation), mechanism of vesicle formation, vesicle mediated trafficking of proteins

Cell cycle and apoptosis: mechanism of mitosis and meiosis, cell cycle control mechanisms and check points, role of cyclins & cyclin dependent kinases, mechanism of programmed cell death.

Unit-IV: DNA replication: Prokaryotic and eukaryotic DNA replication.
Transcription and post-transcriptional modifications: Plant promoters, RNA polymerases, transcription factors and machinery, regulatory elements, capping, RNA editing, splicing, and polyadenylation, export of m-RNA

Unit-V: Protein synthesis and processing: Genetic code, Ribosome, mechanism of Prokaryotic and eukaryotic translation, regulation, translational proof-reading, translational inhibitors, Post-translational modification of proteins
Regulation of gene expression: regulation of the prokaryotic and eukaryotic genes, operon system (Lac and tryptophan operon), role of chromatin in gene expression and gene silencing.

Course Outcome: The student will be learning about the cellular functions, how the organelles co-ordinate. They will also know how the functional components of cell work, cell cycle, Replication of DNA,Protein synthesis and processing for proper functioning of cellular system.

SUGGESTED READING MATERIAL (ALL LATEST EDITIONS):

1. Smith G M, ***Crptogamic Botany Vol I Algae and Fungi*** ,Mc Graw Hill Publ.
2. Smith G M, ***Crptogamic Botany Vol II Bryophytes and Pteridophytes,*** Mc Graw Hill Publ.
3. Kumar, H. D., ***Introductory Phycology***, East-West Press, New Delhi.

4. Maloy, S. R., Cronan, J. E. Jr. and Freifielder, D., ***Microbial Genetics***, Norosa, New Delhi.
5. Mehrotra, R. S. and Aneja, R. S., ***An Introduction to Mycology***, New Age International, New Delhi.
6. Prescott, L. M., Harley, J. P. and Klen, D. A., ***Microbiology***, WCB- McGra-Hill, New Delhi.
7. Alexopolus, C. J., Mims, C. W. and Blackwel, M, **Introductory Mycology**, John Wiley, New York.
8. Pandey. D.C., ***A Text Book on Algae*** **(simple Photosynthetic Plants)**
9. Vashista, B. R., ***Botany for Degree students, Vol I & II***, Chand & Co, New Delhi.
10. Sharma, O.P., ***Text book of Algae***, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
11. Sharma, O.P. ***Text book of Fungi***, Tata McGraw Hill Publishing Co. New Delhi.
12. Srivastava, J.P. ***Introduction to Fungi,*** Central Book Dept. Allahabad, India.
13. Morris, J., ***An Introduction to the Algae***, Cambridge University Press, U.K
14. Becker WM *et al.*,***The World of the Cell***, Benjamin Cummings
15. Lodish H *et al*., ***Molecular Cell Biology***, Freeman
16. Alberts B *et al*., ***Molecular Biology of the Cell,*** Garland
17. Gerald Karp, ***Cell and Molecular Biology: Concepts and Experiments***, Wiley
18. De Robertis and De Robertis, ***Cell and Molecular Biology,*** Lippincott and Wilkins
19. Phillip Sheeler; Donald E. Bianchi, ***Cell and Molecular Biology,*** John Wiley & Sons
20. Lewin B, ***Genes IX,*** Pearson
21. Brown TA, ***Genomes***, Garland
22. Watson *et al.*,***Molecular Biology of the Gene-*** Pearson
23. C.SPatil, ***Advanced Analytical Techniques,***ABE Books,New Delhi.
24. Plummer, D.T, ***An introduction to Practical Biochemistry,*** Tata McGraw-HillPublishing Co. Ltd., New Delhi

PAPER HC-104	PRACTICAL RELATED TO THEORY PAPER - HC-101, HC-102, HC-103	5 Credits	100 MARKS

Course Objective: The course objective is to impart knowledge on practical aspect of structure of microorganisms, isolation and culture of microbes, lower plants and vascular plants, practical skills on analysis of cell cycle, isolation and analysis bio-molecules along with understanding of their biochemistry.

1. General idea on instruments used in microbiology laboratory.
2. To study the various sterilization techniques used in the microbiology laboratory.
3. Preparation of culture media and plating /slanting techniques(nutrient agar, nutrient broth, MS media)
4. Isolation and culture of microbes (bacteria/fungus) from soil/ water sample.
5. Study of bacterial staining techniques. (Gram staining and acid-fast staining)
6. To check for possible contamination in supplied water sample by coliform test.
7. Study of antibiotic sensitivity test by disc diffusion method
8. Study of PCR demonstration.
9. To separate proteins using PAGE
10. To separate DNA(marker) using AGE.
11. Study of blotting techniques: Southern, Northen and Western blotting , DNA finger printing, DNA sequencing .
12. Study of vegetative and reproductive structure of algae and fungi by preparation of permanent slides .(Based on availability of materials).
13. Study of morphology, anatomy and reproductive structure of bryophytes, pteridophytes, angiosperm and gymnosperm through permanent microscopic preparation and preserved specimens as per the theory.
14. Study of fossil slides / photographs as per theory.
15. Study of plant cell structure (*Rhoeo*, Onion, Crinum)
16. Study of cyclosis (hydrilla/aquatic plants)
17. Measurement of cell size by micrometry
18. Squashing techniques for study of mitosis in onion root tip (Onion/Garlic).
19. Squashing techniques for study of meiosis in flower bud (Onion/*Transdescantia*)
20. To find out mitotic index of dividing cells of *Allium cepa* root tip
21. Study of plasmolysis and de-plasmolysis
22. Study of the cell organelle structure with the help of electron micrographs.
23. Isolation of plant genomic DNA
24. Quantification of DNA by spectrophotometric method.
25. Quantification of RNA by Orcinol method.

Course Outcome: Students will gain practical knowledge on microscopic examination of microorganisms like bacteria, fungi and algae.Students will be learning gametophytic and sporophytic structures of bryophytes, pteridophytes and gymnosperm, isolation and culture of microbes, isolation and quantification of biomolecules like DNA,RNA, different stages of cell cycle.

PAPER AC-101	**Computer Application Course By E-Learning Centre**	**03 Credits**	**50 MARKS**

Common for all PG department.

SEMESTER II

PAPER HC-201	**PLANT SYSTEMATICS AND ANATOMY**	**5Credits**	**100 MARKS**

Course Objective: The course aims to add to understand about the nomenclature, classification of flowering plants, range of floral structure, cladistics in taxonomy,anatomy of plant body, anamolous secondary growth in plants.

UNIT-I:Nomenclature: The species concept, delimitation of taxa and attribution of ranks, salient features of ICN, Typification, Priority and its limitations, effective and valid publications, herbarium methodology, specimen digitization, important herbaria of the world.

UNIT-II:Classification: Phenetic and phylogenetic systems of classification, relative merits and demerits of major system of classification (Bentham & Hooker, Engler-Prantl, Hutchinson, Takhtajan, APG system).

UNIT–III:DiversityandRange of floral structures: Ranales, Asterales, Lamiales, and Leguminales, Poales, Scitaminae and Orchidales

UNIT- IV:Modern taxonomy: Cladistics in taxonomy, conceptual lineage, parallelism and convergence, cladistics in classification of plants, Molecular taxonomy, Numerical Taxonomy **Taxonomic evidences:** Morphology, palynology, anatomy, embryology, cytology and Phytochemistry.

UNIT-V:Anatomy: Anatomy of plant body, secondary vascular tissues and cambium, wood histology, node-internode transition, formation and anatomy of leaf, node floral axis and whorls, formation of resin canals and tyloses, hydrophytic and xerophytic anatomy, anomalous secondary growth, applications of anatomy.

Course Outcome:

The course will impart theoretical knowledge on nomenclature and classification of flowering plants, range of floral structure, anatomy of plant body and applications of anatomy.

PAPER HC-202	GENETICS AND PLANT BREEDING	5 Credits	100 MARKS

Course Objective:

The paper aims to enhance the knowledge of students on chromosome structure, cell cycle, structural and numerical alternation in chromosome, genetic recombination, genetic code, genetics of mitochondria and chloroplast, methods in plant breeding and its application.

Unit-I: Classical genetics: Mendel's experiments and laws of inheritance, gene interactions, modified mendelian dihybrid ratios, Multiple allelism, pseudoallele, complementation test, pleiotrophy, genomic imprinting, pedigree analysis, polygenic inheritance, QTL mapping , numerical**,** Linkage and crossing over, linkage maps, lod score, tetrad analysis, sex linkage, sex determination in plants, Maternal effects, inheritance of chloroplast and mitochondrial genes.

Unit- II Chromatin organization: Chromosome structure and Models, Euchromatin and heterochromatin, Chromosome banding, telocentric chromosome, isochromosome and B chromosome,Transposable genetic elements. Genetic recombination and mapping, Molecular basis of recombination, Role of Rec A and Rec BCD, physical mapping of genes on chromosomes

UNIT-III:Structural and numerical alternation in chromosomes: Spontaneous and induced mutations, Physical and chemical mutagens, Chromosomal aberrations, Meiotic behaviour of deletion, duplication, inversion and translocation, Molecular basis of gene mutation, DNA damage and repair mechanisms, Euploids and aneuploids-classification, origin, induction, cytological features and genetic analysis, Role of polyploidy in evolution and practical significance in crop improvement.

UNIT-IV:Molecular and population genetics:DNA finger printing, RFLP, RAPD, SSR, Identification and mapping of QTLs, gene tagging, Marker assisted selection, in situ hybridization, flow cytometry.

Population genetics: Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; Adaptive radiation, Isolating mechanisms, Speciation, Allopatricity and Sympatricity, Convergent evolution; Sexual selection; Co-evolution.

UNIT-V:Plant Breeding: Objective and Scope of plant breeding, Method of plant breeding – introduction and selection (Pedigree, back cross, mass selection, bulk method), male sterility and heterosis breeding, mutation breeding, Significance and applications of plant breeding.

Course Outcome: Students will learn about genetic recombination and mapping techniques, karyotype analysis, chromosomal aberrations, DNA damage and repair mechanism. Students will gain knowledge on plant breeding techniques for crop improvement. Students will have basic knowledge on molecular markers and their application.

PAPER HC-203	PLANT BIOCHEMISTRY	5 Credits	100 MARKS

Course Objectives: The course has been designed to give a concept on fundamental processes of biochemistry, classification, structure and properties of various biomolecules like proteins, carbohydrates and lipids mechanism of enzyme action and Michaelis-Menten`s equation.

UNIT-I: Fundamental processes in Biochemistry:pH and Hydrogen ion concentration, buffers, Solutions and Colligative properties; Stabilizing interactions (van der Waal`s force, electrostatic interaction, Hydrogen bonding and hydrophobic interactions). Laws of Thermodynamics: Concept of free energy, endergonic and exergonic reaction, coupled reaction, redox reaction.

UNIT-II: Amino acids and Proteins: Structure, classification and properties of Amino acids, peptide bond, Biologically active peptides. Primary, Secondary, Tertiary and Quaternary structure of proteins. Protein folding, motifs and domains, Ramachandran`s plot.

UNIT-III: Carbohydrates: Classification, configuration and conformation of monosaccharide, oligosaccharide and polysaccharide, Derivative of sugars, Structural and storage polysaccharides, Glucosaminoglycans, Proteoglyccans, Glycoproteins and Glycolipids.

UNIT-IV: Lipids: Structure, Classification and physio-chemical properties of lipids. Storage lipids; Triglycerides, long chain fatty acids, Structural lipids; Triglycerides (Mono-, Di- and Tri-acylglycerols), Phospholipids and Sterols, Signaling lipids,Glycerophospholipids, Sphingolipids, Cereamides, Terpenes and Wax.

Secondary metabolites: Importance of secondary metabolites, biosynthesis of terpenes, phenols and their significance.

UNIT-V: Enzymes: Classification and nomenclature, Michaelis-Menten`s kinetics and Briggs-Haldane`s modification. Determination of Km and Vmax. Mechanism of enzyme action. General acid-base catalysis, Covalent catalysis and Metal catalysis, Mechanism of action of Chymotrypsin and Ribonuclease, Competitive and non-competitive enzyme inhibition, Determination of inhibition constant, regulation of enzyme activity (Allosteric regulation, covalent modification and feedback regulation).

Course learning outcomes: The course enables the students to gain knowledge on fundamental processes in biochemistry, structure, types and properties of biomolecules, secondary metabolites and mechanism of enzyme action and regulation.

PAPER HC-204	PRACTICAL RELATED TO THEORY PAPER - HC-201, HC-202, HC-203 and CE-	5 Credits	100 MARKS

	201		

Course Objective: The course objective is to impart knowledge on practical aspects of vegetative and floral characters of the families, secondary growth in dicot stem and root, pedigree analysis ,quantification of carbohydrates, proteins and lipids.

1. Study of vegetative and floral characters of the families as in theory syllabus. Description, V.S of flower, section of ovary, floral diagram /s, formal formula/e and systematic position according to Bentham and Hooker's system of classification.
2. Description of various species of a genus and preparation of a key at generic level.
3. Mounting of properly dried and pressed specimen of any ten wild plants with herbarium label.
4. Study of distribution and types of parenchyma, collenchyma and sclerenchyma,
    a. Xylem: Tracheary elements- tracheid, vessel elements, thickenings,perforation plates,xylem fibers.
5. Study of wood anatomy through temporary and permanent slides.
6. Root: monocot, dicot, secondary growth.
7. Stem: monocot, dicot- primary and secondary growth (normal and anomalous); periderm, lenticels.
8. Analysis of allelic and genotypic frequencies.
9. Chromosome mapping using test cross data.
10. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
11. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
12. Blood typing: ABO groups and Rh factor.
13. Selfing and Crossing technique.
14. Learning techniques in hybrid seed production using male-sterility in field crops.
15. Study of Spectrophotometer and its principle and verification of Beer- Lambert's law.
16. Preparation of standard curve for quantification of protein by Lowry`s method/ Bradford`s method.
17. Preparation of standard curve for quantification of carbohydrate by Anthrone`s reagent method.
18. Preparation of standard curve for quantification of lipid by Vanillin method.
19. Effect of substrate concentration on activity of any enzyme and determination of Km value (Acid phosphatase/ Peroxidase/ Catalase).

Course Outcome: Students will gain knowledge on practical aspects of vegetative and floral characters of the families, secondary growth in dicot stem and root, pedigree analysis, quantification of carbohydrates, proteins and lipids

PAPER CE-201	A. RESEARCH METHODOLOGY	5 Credits	100 MARKS

Course Objective: The main objective is to enable students about how to design a research, how to write properly a research paper, to do report writing, use of statistical methods to analyze data in research.

Unit I: Research Methodology-An Introduction: Meaning, objectives, motivations and utility of research, types and methods of research, scientific methods and its characteristics, research ethics and empiricism

Unit II: From philosophy of science to research design: Research process, theory building and understanding the language of research, literature review process and formulation of research questions, hypothesis-characteristics and types, concept and importance of research design, types and uses of research design.

Unit III: Data analysis and interpretation: Concepts of statistical population and sampling, Basics of data collection and analysis, Concepts of biostatistics- measure of central tendency and dispersion, testing of hypothesis, test of significance (t-test, F-test, and Chi-square test), simple linear regression and correlation, correlation coefficient.

Unit IV: Interpretation and Report Writing: Technique of Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Scientific Presentation, IPR and Patent writing, Skills in Scientific communications.

Unit V: Use of ICTs in Research: Understanding and using the library and the internet for research, Computer tools for data processing and analysis.

Citation, References, and Bibliography: Formats and styles, software for reference management and detection of plagiarism; Quoting, Paraphrasing, and avoiding plagiarism.

Course Outcome: Students will develop skills to design a research, to learn the methods of research, would be enabled to have independent thinking, and would write proper research papers.

PAPER CE-201	B. SWAYAM COURSE ON RESEARCH METHODOLOGY	5 Credits	100 MARKS

PAPER OE-201	A. ENVIRONMENT AND DISASTER MANAGEMENT	4 Credits	50 MARKS

Course objective

The course will enable the students to find out solution for a sustainable Earth for future generation, make the stake holder aware of their rights, responsibilities, consequence of their conduct towards nature and build resilience, to develop a sense of equitable use of resources and their preservation for the future generation and Sensitize the stakeholders on disaster preparedness.

Unit-I: Environment:

TheEnvironment: The Atmosphere, Lithosphere, Hydrosphere, Biosphere **Ecosystem:** Energy flow in the ecosystem**, Biogeochemical Cycle:** Water Cycle, Carbon Cycle, Nitrogen Cycle, **Pollution:** Water Pollution, Air Pollution, Soil Pollution.

Environmental Laws: (Water Act 1974, Air act 1981, The Wildlife Protection Act 1972, The Environment Protection Act 1986), The Forest Conservation Act1980.

Unit-II : Climate Change& Sustainable Development:

Population Ecology: Individuals, Species, Population, Community, Human Population Growth, Population Control Methods, Urbanization and its effect on society, **Climate Change:** Cause, Effect, Global Warming, Carbon Footprint and environmental protection,**Step taken towards Sustainable Development:** Ban of single use plastic automobile Scrapping Policy, Promotion of Electrical Vehicles

Brief idea on Sustainable Development Goals (SDGs), Agenda 21 of Rio Earth Summit

Unit-III: Disaster Management: Types of Disasters, Difference between hazard and disaster (Natural and Man-made and their cause and effect) Changes in coastal zone, coastal erosion, beach protection, coastal erosion due to natural and man-made structures. Mitigation measures and management of disaster.

Vulnerability Assessment and Risk Analysis: Vulnerability to various disasters (Flood, Cyclone, Earthquake, Heatwaves and Lightning).

Institutional Framework: Institutional arrangements for disaster management (National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA), National Disaster Response Force (NDRF) and Odisha Disaster Rapid Action Force (ODRAF).

UNIT-IV: Preparedness Measure: Disaster Management Cycle, Disaster management Policy, Early Warning System, Pre-Disaster and Post-Disaster Preparedness, Strengthening of SDMA and DDMA, Community Preparedness, Stakeholder Participation, Corporate Social Responsibility (CSR).

Survival Skills: Survival skills adopted during and after disaster Flood, Cyclone, Earthquake, Heatwaves and Lightning.

Learning outcome:

On successful completion of the course students will be able to identify the historical origins of destructive attitudes and practices towards the natural environment, know the compatibility of human and environment/ecological values, understand the disaster and pandemic they are facing and empower the new generation to face the new challenges.

PAPER –OE-201	B. SWAYAM COURSE ENERGY RESOURCES AND CONVERSION PROCESSES	4 Credits	50 MARKS

Course layout

Week 1.Introduction to Energy and its Various Forms

Week 2.Conventional Energy Sources

Week 3.World Scenario of Energy Sources

Week 4.Renewable Energy Scenario:Hydro Power

Week 5. Biomass Energy

Week 6. Biogas Energy

Week 7. Solar Energy

Week 8. Wind Energy

Week 9. Other Forms of Renewable Energy

Week 10 Principles of Energy Conversion

Week 11. Fuels and Their Characteristics

Week 12. Combustion of Fuels

Week 13. life cycle analysis

Week 14. Environmental Impacts of Energy Conversion

SUGGESTED READING MATERIALS (ALL LATEST EDITIONS)

1. Lubert Stryer *et al.*,***Biochemistry***, New York, Freeman.
2. David L Nelson and Michael M. Cox Lehninger, ***Principles of Biochemistry***, W.H.Freeman

3. Donald Voet, Judith G. Voet, ***Biochemistry***, John Wiley & Sons
4. Dobson, C. M. (2003) ***Protein folding and misfolding***, *Nature*, *426* (6968), 884-890. doi:10.1038/nature02261.
5. Richards, F. M. (1991). ***The Protein Folding Problem***, *Scientific American, 264*(1), 54-63. doi:10.1038/scientific american 0191-54.
6. Satyanarayan U and Chandrapani v, ***Essential of Biochemistry***, Books and Allied (P) Ltd.
7. Buchannan B, Gruiseem W, Jones R, ***Biochemistry and Molecular Biology of Plants***, ASPP, Maryland
8. Lea PJ, Leegood RC, ***Plant Biochemistry and Molecular Biology***; John Wiley & Sons
9. Taiz L and Zeiger E, ***Plant Physiology***; Sinauer Associates, INC
10. C.R.Kothari, Gourav Garg, ***Research Methodology: Methods and Techniques,*** New Age International Publisher.
11. Yogesh Kumar Singh, ***Fundamental of Research Methodology and Statistics***, New Age International Publisher.
12. Sokal R.R. and Rolf, F.J.: ***Biometry***; Freeman, San Francisco.
13. Batschelet, E., ***Introduction to mathematics for life scientists***. Springer Science & Business Media.
14. Murray J.D., ***Mathematical Biology***. Springer, Verlag, Berlin.
15. Quinn &Keough, ***Experimental Design and data Analysis for Biologists***, Cambridge University Press.
16. Green, R.H. ***Sampling design and statistical methods for environmental biologists,***Wiley.
17. G.D. Rai, Non conventional energy sources, Khanna publication
18. Sameer Sarkar, Fuel Technology, New Delhi, orient longman
19. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi
20. Sharma O.P. , ***Plant Taxonomy***, Tata McGraw Hill Publisher
21. Sambamurty, A. V. S. S., ***Taxonomy of Angiosperms***, I. K. International Pvt.Ltd., New Delhi.
22. Mitra, J.N., ***An Introduction to Systematics***, Oxford & IBH Publishers, New Delhi
23. Lawrence G.H., ***Taxonomy of Vascular Plants***, Prentice Hall College Div
    a. Publishers

24. Bhojwani, S.S. and Bhatnagar, S. P., ***The Embryology of Angiosperms***, Vikas Publishing House, New Delhi.
25. Raghavan, V, ***Molecular Embryology of Flowering Plant***, Cambridge University Press, Cambridge.

SEMESTER III

PAPER HC-301	PLANT PHYSIOLOGY AND DEVELOPMENT	5 Credits	100 MARKS

Course Objective: The course has been designed to give an overview on membrane transport processes, translocation of water and solutes, transpiration and stomatal movement, photosynthesis, respiration, lipid and nitrogen metabolism, responses of plants to different stresses, plant growth regulators and their mechanism of action, differentiation of meristematic tissues and developmental biology.

UNIT-I: Water Absorption and Membrane transport: Absorption of water and transport through xylem, Transport of ions, solutes and macromolecules across membrane barrier, Membrane transport proteins, Membrane transport processes, Transpiration and its significance; stomatal movement, Phloem loading and unloading.

UNIT-II Photosynthesis: General concept, Photosynthetic pigments and light harvesting complexes, photo-oxidation of water and evolution of oxygen, mechanism of Z- scheme electron transport process; Redox potential and ATP synthesis. Carbon assimilation: C3,C4 and CAM pathway, Photorespiration.

UNIT-IIIRespiration: Glycolysis, TCA cycle, electron transport system and oxidative phosphorylation, Alternative oxidase pathway, Biosynthesis and oxidation of fatty acids; regulation of fatty acid metabolism .

Nitrogen metabolism:An overview,biological N2 fixation, mechanism of nitrate uptake and its reduction, Nitrate and Ammonium assimilation, biosynthesis of amino acids.

UNIT-IVStress physiology: Responses of plants to biotic(pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanism of stress resistance and tolerance, HR and SAR, Metal toxicity, Oxidative stress.

Plant growth regulators: Physiological effects, mechanism of action and application of plant growth regulators. Growth movement.

Photoreceptor: Structure and function of phytochromes, cryptochromes, phototropins and their role in regulation of plant morphogenesis.

Flowering: Phenomenon of flowering, photoperiodism, vernalization and biological clocks.

UNIT-VDifferentiation and development:Plant cell development with unique features, molecular analysis of shoot apical meristem, root apical meristem and leaf growth, transition to flowering, ABC model of floral organs development, vascular tissue differentiation of root, shoot and leaf, molecular and cytological analysis of endosperm and fruit development, fruit ripening and its manipulation.

Course Outcome: This course enables the students to learn mechanism of membrane transport,translocation through xylem and phloem, mechanism of photosynthesis and respiration. Students will gain knowledge on biosynthesis of fatty acids and degradation, nitrogen metabolism,stress physiology, plant growth regulators and phenomenon of flowering in plants, differentiation of meristematic tissues and developmental biology.

PAPER HC-302	**PLANT BIOTECHNOLOGY AND RESOURCE UTILIZATION**	**5 Credits**	**100 MARKS**

Course objective: This course would provide students with an understanding of principles and techniques of plant tissue culture, concepts and methods associated with development and analysis of transgenic plants, and their applications in basic and applied research. The students would be exposed to the economic importance and current research paradigms in various categories of commercially cultivated plants.

UNIT-I:Plant Cell, Tissue & Organ Culture: Micropropagation, Callus-mediated organogenesis, Adventitious organogenesis, Somatic embryogenesis, Synthetic seeds, Haploids through anther, microspore & ovary culture, Embryo rescue, Somaclonal variation, Cell suspension culture.

UNIT-II:Somatic Hybridization and Cybridization: Protoplast isolation and culture, chemical & electro fusion of protoplasts: Principle and techniques, post-fusion selection, Characterization of somatic hybrids, Asymmetric hybrids &cybrids, Somatic hybrids and cybrids for crop improvement.

UNIT-III: Recombinant DNA Technology: Molecular tools; Restriction enzymes, Cloning vectors (plasmids, lambda & M13 phage DNA, cosmids, phagemids, artificial chromosomes-YAC, BAC, PAC), Construction of recombinant DNA and expression cassettes, Mobilization of vectors intocompetent bacteria, Selection and analysis of recombinant clones, Genomic DNA and cDNA libraries, PCR and its types

UNIT-IV:Vector-mediated Gene Transfer to Plants: Plant virus vectors, Molecular basis of crown gall and hairy root diseases, Features of Ti and Ri plasmids of Agrobacterium, Mechanism of T-DNA transfer, Role of virulence genes, Hairy root cultures as source of pharmaceuticals, Vectors based on pTi&pRi, Binary and co-integrate vectors.

UNIT-V: Plant resource utilization: Centres of primary diversity and secondary centres of cultivated plants, crop domestication genes, introduction to current research paradigms in major cereals, oilseeds, legumes, medicinal plants, forest trees, non-alcoholic beverages.

Learning outcome: The students will learn about the concept of in vitro propagation of plants, they will know about the techniques of cloning, gene transfer and transformation, utilization of plant resources.

PAPER HC-303	**PRACTICAL RELATED TO THEORY PAPER - HC-301, HC-302**	**5 Credits**	**100 MARKS**

Course objective:

The course aims to educate the students on different practical aspects like techniques of spectrophotometer, protein separation by electrophoresis, efficiency analysis of plants under different stress, anther culture, preparation of tissue culture medium.

1. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
2. Measurement of relation between transpiration and transpiring surface.
3. Study of Spectrophotometer and its principle and verification of Beer- Lambert's law.
4. Study of plant efficiency analysis under light and temperature stress.
5. Extraction of pigments from leaves and preparation of absorption spectra for chlorophyll and carotenoids.
6. Protein separation by SDS-PAGE.
7. Study of permanent/temporary slides showing SAM.
8. Study of permanent/temporary slides showing RAM.
9. Study of permanent/ temporary slides showing the origin of leaf primordial in L.S of shoot apex.
10. A) Preparation of tissue culture (MS) medium. B) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of Tobacco, Datura and Brassica etc.
11. Study ofanther culture.
12. Isolation of plasmid DNA.
13. Gel electrophoresis.
14. Legumes: Soya bean/ moong bean / black gram , ground nut (habit, fruit, seed structure, micro- chemical tests)
15. Cereals: Rice (habit sketch, study of paddy and grain, starch grains).
16. Non alcoholic beverages: Tea (plant specimen, tea leaves), Coffee (plant specimens, beans).
17. Drug yielding plants: Specimens of *Digitalis*, *Papaver* and *Cannabis*.

Learning outcome: The students will gain knowledge on technique of spectrophotometry, gel electrophoresis, preparation of tissue culture method, anther culture and some economically important plants and their products**.**

PAPER CE-301	A. BIOCHEMISTRY AND MOLECULAR BIOLOGY-I	5 Credits	100 MARKS

Course objective: The course aims to educate the students about various biomolecules like aminoacidsproteins, carbohydrates, lipids and basics of immunology.

UNIT-I: Amino acids: Classification, structure and properties, Proteins: Primary, Secondary, tertiary and quaternary structure, determination of amino acid sequence, Protein folding.
UNIT-II: Enzymology: extraction, assay and purification of enzymes; Enzyme kinetics: Michaelis-Menten equation and Briggs-Haldane modification; Determination of Km, Competitive, non-competitive and un-competitive inhibition of enzymes, Determination of inhibition constant. Mechanism of action of Chymotrypsin and Ribonuclease, Regulation of enzyme activity (covalent modification, feedback regulation and allosteric control), Industrial and clinical application of enzymes.
UNIT-III: Carbohydrate Metabolism: Regulation of Calvin cycle, HSK pathway, CAM pathway, Glycolysis, TCA cycle and oxidative pentose phosphate pathway, electron transport chain (Chloroplast and Mitochondrial), photophosphorylation and oxidative phosphorylation, Hydrolysis and biosynthesis of starch and sucrose.
UNIT-IV: Lipid Metabolism: Biosynthesis and hydrolysis of triacylglycerols, structural lipids of membranes, fatty acids; Oxidation of fatty acids; Gluconeogenesis. Cell signalling and signal transduction.

UNIT-V: Immune system: Lymphocytes and accessory cells, Immunoglobulins, MHC, Toll like receptors, mechanism of immune response and generation of antibody diversity, Effectors, complements, hypersensitivity and autoimmunity, AIDS and other immunodeficiency, vaccines, Hybridoma and Mabs, Immunological techniques (ELISA, RIA, western blot, immunoprecipitation, FISH and GISH.
Course Learning Outcomes:
Students will be learning about protein conformation, enzyme kinetics, regulation of enzyme activity, regulation of carbohydrate metabolism, oxidation of fatty acids, cell signaling and signal transduction. Students will gain knowledge on immunoglobulins, mechanism of immune response, vaccines and immunological technique.

PAPER CE-301	B. MICROBIAL TECHNOLOGY-I	5 Credits	100 MARKS

Course Objectives:

The course aims to educate student on microbial culture, immunology, soil microbiology, microbes in metal recovery, molecular techniques and industrial microbiology.

UNIT-I: Microbes and Growth: History and milestones in the development of microbiology, classification of microorganisms, Microbial culture methods: isolation, purification, growth, maintenance and preservation of microbes, axenic and synchronous culture, batch and continuous culture. Metabolic groups of bacteria, ultra-structure and composition of bacterial cell wall, cell inclusions and nucleic acids, reproduction, bacterial metabolism.

UNIT-II: Immunology: Immune system, Lymphocytes and accessory cells, Immunoglobulins, mechanism of immune response and generation of antibody diversity, Effectors, complements, auto-immunity, AIDS and other immunodeficiency, Hybridoma and Mabs, Immunological techniques: detection of molecules using ELISA, RIA, western blot, flow-cytometry.

UNIT-III: Microbial Activity in various habitats:

Soil microbiology: surface and deep surface microbes, water microbiology: microbes of freshwater andmarine habitats; aero microbiology: microbes in atmosphere, microbial activity and biogeochemical cycle. Wastewater microbes, microbial aspects of waste water treatment, biofilm structure and development, microbial interaction in biofilm, degradation of industrial pollutants and organic carbon, pesticide, hydrocarbon removal by microbes.

UNIT-IV: Microbial Application:

Microbes in mining and bioleaching of metals, Bio-accumulation and its characteristics, determination of biodegradability, microbial transformation of metals, wasteland reclamation, biogas, composting, non-reactor and reactor composting method.

UNIT-V: Microbes in Industry:

Isolation of DNA, Restriction modification of DNA, Agarose gel electrophoresis, PCR in environmentalmicrobiology, DGGE, Microbial finger printing of environmental samples. r RNA sequencing, Ribotyping. Fermenter,design of bioreactor, batch and continuous fermentation, downstream processing, industrial production of organic acids, alcohol, enzymes and antibiotics.

Course Learning Outcomes:Students will be learning about classification of microorganisms and microbial culture methods, immunoglobulins and mechanism of immune response, immunological techniques, soil, water and aero microbiology, microbes in mining and bioleaching of metals, isolation of DNA, Agarose gel electrophoresis, PCR, fermenter and industrial application

PAPER CE-302	A. BIOCHEMISTRY AND MOLECULAR BIOLOGY-II	5 Credits	100 MARKS

Course objective: Course Objectives:
The course aims to educate student on DNA replication, transcription, translation, gene regulation, genetic marker, antisense and ribozyme technology**.**

UNIT-I: DNA replication, Transcription: Enzymes and necessary protein in DNA replication, DNA damage, repair and recombination, Prokaryotic and eukaryotic transcription mechanisms, posttranscriptional modification of RNA, Nuclear export of m-RNA.
UNIT-II: Translation: Prokaryotic and eukaryotic translation, Regulation and posttranslational modification of proteins, protein import into nucleus, chloroplast, mitochondria and peroxisomes. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors.
UNIT-III: Gene Regulation: Regulation of gene expression in prokaryotes and eukaryotes (lac-operon, trp-operon, ara-operon, attenuation and anti-termination).
UNIT-IV: Genetic Marker: t-DNA and transposon tagging, targeted gene replacement, augmentation, gene knockout, vector engineering, gene correction and editing, molecular makers in genome analysis, (RFLP, RAPD and AFLP, ISSR and SSR and SNP).
UNIT-V: Antisense and Ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping. Biochemistry of ribozyme (hammer-head, hairpin and other ribozymes), designing of ribozymes. Applications of antisense and ribozyme technologies.

Course Learning Outcomes:
Students will be learning about DNA replication, DNA damage, repair and recombination, Prokaryotic and eukaryotic translation, regulation of gene expression in prokaryotes and eukaryotes, gene correction and editing, molecular makers in genome analysis, designing of ribozymes, applications of antisense and ribozyme technologies.

PAPER CE-302	B. MICROBIAL TECHNOLOGY-II	5 Credits	100 MARKS

Course Objectives:
The course aims to educate student on role of microbes in soil fertility, Microbial nutrition, industrial microbiology, Microbial interaction and microbes as plant pathogen**.**

UNIT-I: Microbes in soil fertility: Nutrient metabolism, organic nitrogen transformation, phosphate solubilization,microbial association in soil. Lignocellulotytic and cellulolytic microbes, catabolic degradation. Biofertilisers: Types, methods of production, stain

improvement, application and economics of Rhizobium, Azotobactor, Azospirllum, Mycorrhiza, Cyanobactria**.**

UNIT-II: Microbial nutrition: Photo-autotrophs, chemo-lithotrophs, photo-organotrophs, chemoorganotrophs, photosynthetic pigments of bacteria, symbiotic and asymbiotic nitrogen fixation by bacteria; nitrification and denitrification

UNIT-III: Microbes in Industry: Fermenter, design of bio-reactor, batch and continuous fermentation, down stream processing, industrial production of organic acids, alcohol, enzymes and antibiotics. Microbes in food: Principles of food preservation, contamination and food spoilage, microbiology of milk, processing and milk products, single cell protein-yeast, Chlorella, Spirulina, mushroom cultivation, microbial technology for pigments; biohydrogen and biodiesel.

UNIT-IV: Microbial interaction: microbe-microbe, plant microbe and animal-microbe interaction, proto-cooperation, parasitism, commensalism, competition, neutralism and mutualism, microbial contribution to animalnutrition, pathogenic and non-pathogen interaction in plants**.**

UNIT-V: Pathogenicity:

Plant disease development, host-parasite relation, biochemical basis of pathogenic invasion, disease resistance, phyto- immunity, microbial toxins, biocontrol of diseases.

Course Learning Outcomes:

Students will be learning about microbial nutrient metabolism, biofertilizers, nutritional types of microbes, nitrogen fixation, bio-reactors, downstream processing and microbes as food, microbe-microbe, plant-microbe and animal-microbe interaction.

PAPER Fl-301	**FIELD INTERNSHIP**	**3 Credits**	**50 MARKS**

Course Objectives: The course aims to educate students on practical experience and how the systems work.

- Enable them to learn new skills
- Mark a valuable addition to their biodata.
- Allows them to meet new people and system.

Student will go for field survey/field internship to study and would prepare a report on the same.

Learning Outcomes: The skill and practical outlook of the students will be enhanced.

SUGGESTED READING MATERIALS (ALL LATEST EDITIONS)

1. R.C.Dubey and Maheshwari.D.K., ***A Text book of Microbiology***, S.C. Chand and Company, Ltd. Ramnagar, New Delhi.
2. S.B.Sullia and Shantharam. S.,***General Microbiology***. Oxford and IBH publishing Co. Pvt.Ltd. New Delhi.
3. Sharma. P.D., ***Microbiology and Plant Pathology***, Rastogi publications. Meerut, India.
4. Ananthnarayan, R and Jayaram Panikar,C.K., ***Text book of Microbiology***, Orient Longman ltd. New Delhi.
5. Brook, T.D. Smith, D.W and Madigan, M.T. ***Biology of Microorganisms,*** Eaglewood Cliffts, N.J.Prentice- Hall, New Delhi.
6. Claus, William, G., ***Understanding microbes. A laboratory text book for Microbiology***, W.H.Freeman and Company, New York.
7. Ketchum, PA., ***Microbiology, concepts and applications***, John Wiley and Sons. New York.
8. Stainer, Roger, Y. Ingrahan, John, L. Wheelis, Mark,L and Painter, Page,R. ,***Microbial Worl,*** Prentice-Hall India, Pvt.Ltd., New Delhi.
9. Schlegel, H.G., ***General Microbiology***, Cambridge University Press, London,.
10. Sharma, R.2006. ***Text book of Microbiology,*** Mittal Publications. New Delhi. 305pp.
11. Prescott, L. M., Harley, J. P. and Klen, D. A., ***Microbiology,*** McGraw-Hill, New Delhi
12. Mehrothra, R.S., ***Plant Pathology***, Tata McGraw Hill Publishing Co. New Delhi
13. Rangaswami,G.& A.Mahadevan, ***Diseases of Crop plants in India***, Prentice Hall ofIndia (P) Ltd. New Delhi.1998.
14. Buchanan. B.B. guissem, W. and Jones RL, ***Biochemistry and Molecular Biology of Plants***, American Society of Plant Physiologist, Maryland, USA
15. Dechis, D.T. Turpin, D.H., Lefebvre, D.D. and Layzell, D, ***Plant Metabolism***, Longman, Essex, England
16. Galston, A W., ***Life Processes in Plants***, Scientific American Library, Springer - Verlag, New York, USA
17. Singhal, G.S. Renge, G., Sopory, S.K Irrgang, KD. and Govingjee, ***Concepts in Photobiology Photosynthesis and Photomorphogenesis***. Narosa Publishing House, New Delhi

18. Hopkins, ***Introduction to Plant Physiology***, W.G. John Wiley and sons. Inc., New York, USA

19. Salisbury F.B. and Ross C.W, ***Plant Physiology***, Words Worth Publishing Co. California, USA

20. Taiz,L and Zeiger, E., ***Plant Physiology,*** Sinauer associate. Inc Publishers Massachusetts, USA

21. Noogie, C.R and Fritz, ***Introductory Plant Physiology***, G.J, , Prentice Hall

22. Wilkins M.B, ***Advanced Plant Physiology***, ELBS

23. Moore T.C., ***Biochemistry and Plant Physiology of Plant Hormones***, Springer-Verlag New York, USA

24. Thomas B. and Vince-Prrune, D., ***Photoperiodism in Plant***, Academic Press, San Diego, USA

SEMESTER-IV

PAPER HC-401	ECOLOGY, EVOLUTION AND REPRODUCTION	5 Credits	100 MARKS

Course objective: The course aims to add to understanding of the students about the nomenclature, classification and diversity of flowering plants. Students will be taught about ecosystem, population and community ecology. Students will be exposed to concepts of evolution and population genetics.

UNIT-I:Ecosystem Ecology: Physical and biotic environment, Structure and function of terrestrial and aquatic ecosystem, Energy flow: sources and pattern; Mineral cycling (C, N, P). Primary production and decomposition. Concept of habitat and niche, niche width and overlap, fundamentals and realized niche, resource partitioning and character displacement, ecotone and edge effect

UNIT-II:Population ecology: Population characters, population growth curves, population regulation, life history strategies (r and k selections), concept of meta population- Demes, Dispersal,Interdemic extinctions, age structure populations, Species interactions: Types of interactions (positive and negative), interspecific competitions, herbivory, carnivory, pollination, symbiosis. Population regulation:Competitive exclusion ,density dependent and independent regulation , Lotka-Voltera model

UNIT III:Community Ecology: nature, structure and its attributes, levels of species diversity and its measurement. **Ecological succession:** types, mechanism - facilitation, tolerance, and inhibition, changes involved in succession, climax concept.

UNIT-IV:Evolution: Lamarck and Darwin concept of variation ,adaptation and natural selection,origin and evolution of prokaryotes and eukaryotes, origin and development of major group of organisms in geological timescale,molecular evolution.

Biogeography and Conservation biology: Major terrestrial biomes, theory of island biogeography, Bio-geographical zones of India, principle of conservation, major approaches to management, National parks and Biosphere reserve.

UNIT-V:

Self-incompatibility and experimental embryology: Structural and biochemical aspects; methods to overcome incompatibility, in vitro pollination, culture of differentiated and mature embryos; culturing of embryonic segments.

Learning outcome:
Students will gain knowledge on fundamentals of ecology, population and community ecology, evolution of prokaryotes and eukaryotes, bio-geographical zones of India, principle of conservation.

PAPER HC-402	**ADVANCED PRACTICAL RELATED HC-401, CE-301 and CE-302**	**5 Credits**	**100 MARKS**

Course objective: Aim of the course is to impart knowledge on advanced practical relating to plant ecology, embryology, microbiology, molecular biology and biochemistry.

1. T. S. / L. S. of Anther, Ovary and Ovule of angiosperms
2. Observation of permanent slides related to embryology
3. DNA isolation and Purification, quality check in spectrophotometer and gel electrophoresis
4. PCR analysis.
5. Microbial culture, Gram staining, endospore staining, Micorrhiza fungi staining
8. Antimicrobial assay
10. Isolation, purification and culture (bacteria/ fungus)
11. Quantitative analysis of protein, carbohydrate, chlorophyll, proline, sugar etc.
12. Phytochemical isolation, qualitative and quantitative analysis of phytochemicals by Spectrophotometer/TLC/HPLC etc
12. Determine the required size of quadrat to study the vegetation by species area curve method.
13. Determine the required number of quadrat to study the vegetation in a given area by species area curve method.
14. Analyze the vegetation by quadrat method. A) line transect B) Belt transect method.

Course Learning Outcomes: Students will gain hand on isolation and Purification DNA, PCR , electrophoresis, antimicrobial assay, Quantification of protein, carbohydrate, chlorophyll, proline, sugar etc., phytochemical analysis by TLC/ HPLC.

SUGGESTED READING MATERIALS (ALL LATEST EDITION)

1.Sharma, P.D.*Ecology and Environment*. Rastogi Publications, ISBN, 8171339050, 9788171339051. 640 pp.
2. M.C. Dash. *Fundamentals of Ecology*. Mc Graw Hill Education publishers. 504pp.
3. Gomez, K. A. and Gomez, A. A. *Statistical Procedures for Agricultural Research*,. John Weley, New York.
4. Kormondy, E. J. *Concepts of Ecology*, Prentice-Hall India, New Delhi.• Odum, E. P.. Fundamentals of Ecology, Saundas, Philadelphia, USA.
5. Misra, B. N. and Misra, M. K. *Introductory Practical Biostatistics*, Naya prokash, kolkata.
6. Smith, R. L. *Ecology and Field Biology*. Harper Collins, New York.
7.Subrahmanyam, N. S. and Sambamurty, A. V. S. S. *Ecology*. Narosa, New Delhi.
8. Simmonds, N. W. *Evolution of Crop Plants.* Longman, New York.
9. Bewley, J.D. and Black, M. *Seed: physiology of Development and Germination*. Plenum, New York.
10. Bhojwani, S.S. and Bhatnagar, S. P.*The Embryology of Angiosperms*. Vikas Publishing House, New Delhi.
11. Raghavan, V . *Molecular Embryology of Flowering Plant.* Cambridge University Press, Cambridge.
12. Raghavan, V. *Developmental Biology of Flowering Plants*. Springer-Verlag, New York.

PAPER HC-403	SEMINAR	5 Credits	100 MARKS

Course objective:
Objective of the course is to enable to students for public speaking and presentation of a scientific topic.

Semester-IV
Seminar presentation related to concerned papers and their applications.

Course Learning Outcomes:
Students will acquire the skill of public speaking, content development for presentation and discussion

PAPER CE-401	DISSERTATION	5 Credits	100 MARKS

Course objective:
The course aims to develop the skill of experimental design, critical thinking and scientific writing.

Semester-IV
Dissertation work related to concerned papers.

Course Learning Outcomes:
Students will learn how to design experiments, think critically and write dissertation. The course will be a preliminary training to do research.

PAPER AC-401	WOMEN AND SOCIETY	03 Credits	50 MARKS

Common for all PG department.

Other Non- Credit Courses
(Skill Based)
COURSE NAME: Garden and Lawn Care

Course objective: This course enables the students to gain a practical knowledge on developing garden, types of garden, practising lawn making and its maintenance**.**

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

Unit-II Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.
Unit-III: Lawn and turf areas: Identification of lawn grasses and lawn making, Principles, planning and execution of private gardens, public gardens and factory gardens.
Unit-IV: Lawn Maintenance: Mowing, De-thatching/ mulching, aerating,Edging, Irrigation techniques, fertilizers ,Irrigated pest management, Top dressing, Commercial vs. Residential lawns.
Learning Outcomes: Students will learn developing a garden, will identify important ornamental trees, principles of lawn making and maintenance which will help them to acquire a practical expertise in the area.

SUGGESTED READING MATERIALS:

1.Text Book of Nursery, Gardening and Floriculture, Kalyani Publishers, New Delhi.
2. Bose T.K. & Mukherjee, D., Gardening in India, Oxford & IBH Publishing Co.,New Delhi.
3. Sandhu, M.K., Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
4. Kumar, N., Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
5.. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co.,New Delhi.

6. Agrawal, P.K., Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National - Seed Corporation Ltd., New Delhi.
7. Janick Jules. Horticultural Science. W.H. Freeman and Co., San Francisco, USA.