

COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

DEPARTMENT OF BOTANY

Choice Based Credit System (CBCS)

First & Second Semester Examination – 2023-24

Third & Fourth Semester Examination – 2024-25

Fifth & Sixth Semester Examination – 2025-26



**GOVERNMENT AUTONOMOUS COLLEGE,
PHULBANI, KANDHAMAL**

DISTRIBUTION OF MARKS

Paper with Practical	
Mid Sem (15 Marks)	
Two questions to be answered carrying 1 mark each	2X1 mark = 2 marks
Two questions to be answered carrying 1.5 marks each	2X1.5 marks = 3 marks
Two questions to be answered carrying 2 marks each	2X2 marks = 4 marks
One question to be answered carrying 6 marks each	1X6 marks = 6 marks
End Sem (60 Marks)	
Eight questions to be answered carrying 1 mark each	8X1 mark = 8 marks
Eight questions to be answered carrying 1.5 marks each	8X1.5 marks = 12 marks
Eight questions to be answered carrying 2 marks each	8X2 marks = 16 marks
Four questions to be answered carrying 6 marks each	4X6 marks = 24 marks
Paper without Practical	
Mid Sem (20 Marks)	
Three questions to be answered carrying 1 mark each	3X1 mark = 3 marks
Two questions to be answered carrying 2 marks each	2X2 marks = 4 marks
Two questions to be answered carrying 3 marks each	2X3 marks = 6 marks
One question to be answered carrying 7 marks each	1X7 marks = 7 marks
End Sem (80 Marks)	
Twelve questions to be answered carrying 1 mark each	12X1 mark = 12 marks
Eight questions to be answered carrying 2 marks each	8X2 marks = 16 marks
Eight questions to be answered carrying 3 marks each	8X3 marks = 24 marks
Four questions to be answered carrying 7 marks each	4X7 marks = 28 marks

PROGRAM OUTCOMES:

B.SC Botany syllabus imparts students with the knowledge to get ahead in the career path they choose and help them for rewarding a jobs. Program of the department has been designed to facilitate the students with both theoretical and practical knowledge that it makes students learn about all the essential skills they require to succeed in their career paths.

Program has also been designed to facilitate knowledge among the students and to inculcate the scientific temperament inside the students and outside the scientific community.

PROGRAM SPECIFIC OUTCOMES:

- After completing the course, a student is able to understand different branches of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.
- A student can identify various life forms of plants, design and execute experiments related to basic studies on evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, proteomics and transgenic technology.
- Students are also familiarized with the use of bio-informatics tools and databases and in the application of statistics to biological data.

Govt. Autonomous College, Phulbani

SYLLABI FOR CBCS COURSE

Sem	CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	AECC-I AECC-III(EV-I)			GE-IA
	CORE-II				
II	CORE-III	AECC-II AECC-III(EV-II)			GE-1B
	CORE-IV				
III	CORE-V	AECC-III(EV-III)	SEC-I		GE-2A
	CORE-VI				
	CORE-VII				
IV	CORE-VIII	AECC-III(EV-IV)	SEC-II		GE-2B
	CORE-IX				
	CORE-X				
V	CORE-XI	AECC-III(EV-V)		DSE-I	
	CORE-XII			DSE-II	
VI	CORE-XIII	AECC-III(EV-VI)		DSE-III	
	CORE-XIV			DSE-IV / Project	

YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

Three-Year (6-Semester) CBCS Programme (B.Sc. Hons) (Botany Department)				
Yr.	Sl.No.	Course Structure	Code	Credit Points
FIRST YEAR	SEMESTER-I			
	1	Microbiology and Phycology	C-1.1	4+2
	2	Biomolecules and Cell Biology	C-1.2	4+2
	3			
	4	Environmental Studies & Disaster Management (For Science)	AECC-1.4	4
	5	Ethics & Values (Unit-I)	AECC-1.5	1
	SEMESTER-II			
	6	Mycology and Phytopathology	C-2.1	4+2
	7	Archegoniate	C-2.2	4+2
	8	Plant Physiology & Metabolism	GE-2.3	4+2
9				
10	Ethics & Values (Unit-II)	AECC-2.5	1	
SECOND YEAR	SEMESTER-III			
	11	Anatomy of Angiosperms	C-3.1	4+2
	12	Economic Botany	C-3.2	4+2
	13	Genetics	C-3.3	4+2
	14			
	15			
	16	Ethics & Values (Unit-III)	AECC-3.6	1
	SEMESTER-IV			
	17	Molecular Biology	C-4.1	4+2
	18	Plant Ecology & Phytogeography	C-4.2	4+2
	19	Plant Systematics	C-4.3	4+2
	20	Plant Ecology & Taxonomy	GE-4.4	4+2
21				
22	Ethics & Values (Unit-IV)	AECC-4.6	1	
FINAL YEAR	SEMESTER-V			
	23	Reproductive Biology of Angiosperms	C-5.1	4+2
	24	Plant Physiology	C-5.2	4+2
	25	Analytical Techniques in Plants Sciences	DSE-5.3	4+2
	26	Natural Resource Management	DSE-5.4	4+2
	27	Ethics & Values (Unit-V)	AECC-5.5	1
	SEMESTER-VI			
	28	Plant Metabolism	C-6.1	4+2
	29	Plant Biotechnology	C-6.2	4+2
	30	Horticulture Practices & Post Harvest Technology	DSE-6.3	4+2
31	Project Work / Industrial & Environmental Microbiology	DSE-6.4	6 / 4+2	
32	Ethics & Values (Unit-VI)	AECC-6.5	1	

Notes:

- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- SECC- Skill Enhancement Compulsory Course (Skill Based)
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours

SEMESTER-I

C-1.1 : MICROBIOLOGY AND PHYCOLOGY

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives

To get vivid knowledge about classification, characteristic, and ultra-structure of prokaryotic microbial diversity and the structure, pigmentation, food reserve, methods of reproduction and economic importance of Algae.

THEORY

UNIT-I

Introduction to microbial world, microbial nutrition, growth and metabolism. **Viruses:-** Discovery, physicochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

UNIT-II

- i. **Bacteria:-** Discovery, general characteristics, types- archaeobacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).
- ii. **Cyanobacteria:-** Ecology and occurrence, cell structure, heterocyst, reproduction, economic importance; role in biotechnology. Morphology and life-cycle of *Nostoc*. General characteristics of prochlorophyceae, Evolutionary significance of Prochloron.

UNIT-III

- i. **Algae:-** General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Role of algae in the environment, agriculture, biotechnology and industry.
- ii. **Chlorophyta:-** General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Chlamydomonas*, *Volvox*, *Oedogonium* and *Coleochaete*.

UNIT-IV

- i. **Charophyta:-** General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*; evolutionary significance.
- ii. **Xanthophyta:-** General characteristics; Occurrence, morphology and life- cycle of *Vaucheria*.
- iii. **Phaeophyta:-** Characteristics, occurrence, cell structure and reproduction. Morphology and life-cycles of *Ectocarpus* and *Fucus*.
Rhodophyta:- General characteristics, occurrence, cell structure and reproduction. Morphology and life-cycle of *Polysiphonia*.

PRACTICAL

Microbiology

- i. Electron micrographs/Models of viruses –T-Phage and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle.
- ii. Types of Bacteria to be observed from temporary/permanent slides/photographs.
- iii. Examination of bacteria from bacterial culture by Gram's staining method.
- iv. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule (live materials and photographs).

Phycology

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

Outcomes

- Get knowledge about host parasite interaction as per process
- Know about organism and causal factor responsible for plant diseases and methods of studying plant diseases.

Text Books:

1. Singh, V., Pandey, P.C., and Jain, D.K. (2017). Microbiology and Phycology, Rastogi Publication, Meerut.

Reference Books:

- ❖ Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
- ❖ Prescott, L.M., Harley J.P., Klein D. A. (2010). Microbiology, McGraw-Hill, India. 8th edition.
- ❖ Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
- ❖ Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
- ❖ Pelczar, M.J., Chan, E.C.S., Krieg, N.R. (2011) Microbiology, 8th edition, Tata McGraw-Hill Co, New Delhi.
- ❖ Willey, Sherwood and Christopher. Laboratory exercises in Microbiology. McGraw-Hill, India. 9th edition.
- ❖ Vasistha B.R. (2017) Botany for Degree student, Algae, S. Chand Publication, New Delhi.
- ❖ Mishra B. K. (2018) Microbiology and Phycology, Kalyani Publishers, New Delhi.

C-1.2 : BIOMOLECULES AND CELL BIOLOGY

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives:

Gain skill on working principle of pH meter, mechanism of enzyme action and gain knowledge of fixation dehydration, structure, chemistry and function of cellular organelles.

THEORY

UNIT –I

- i. Biomolecules and Bioenergetics: Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions.
- ii. Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, properties of enzymes, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.
- iii. Carbohydrates: Nomenclature, classification, structure and function of Monosaccharides, Disaccharides, Oligosaccharides and polysaccharides

UNIT –II

- i. Lipids: Definition and major classes of storage and structural lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties.
- ii. Proteins: Structure and classification of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins.
- iii. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

UNIT –III

- i. The Cell: Cell as a UNIT of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).
- ii. Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.
- iii. Cell organelles: Nucleus; Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

UNIT –IV

- i. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.
- ii. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endoplasmic Reticulum, Golgi Apparatus, Lysosomes.
- iii. Cell division: Eukaryotic cell cycle, different stages of mitosis and meiosis. Cell cycle, Regulation of cell cycle.

PRACTICAL

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo*
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Counting the cells per UNIT volume with the help of haemocytometer. (Yeast/pollen grains).
5. Study the phenomenon of plasmolysis and deplasmolysis.
6. Study of different stages of mitosis and meiosis using aceto carmine and aceto orcin method from Onion root tip and bud respectively.

Outcomes

- Describe the evolution, diversity, and replication of cells.
- Learn the properties of enzyme catalysis and activation energy.
- Helps to get lucid information regarding biochemical structures and their implementation in scientific temperament.

Text Books:

1. Rastogi, V. B. (2016). Introductory Cytology, Kedar Nath & Ram Nath, Meerut
2. Gupta, P. K. (2017). Biomolecules and Cell Biology, Rastogi Publication, Meerut.

Reference Books:

- ❖ Sahoo, K. (2017) Biomolecules and Cell Biology, Kalyani Publishers, New Delhi.
- ❖ Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
- ❖ Nelson, D.L. and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.
- ❖ Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- ❖ Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

**AECC-1.4 : ENVIRONMENTAL STUDIES & DISASTER MANAGEMENT
(FOR SCIENCE STREAM)**

**Full Marks – 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs**

UNIT – I (Environment)

The Environment: 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, Radiation Pollution, Industrial Pollution, Light Pollution, Sound Pollution

Environmental Laws : Water Act 1974, Air Act 1981, The Wildlife Protection Act 1972, The Environment Protection Act 1986, The Forest Conservation Act 1980

UNIT – II (Climate Change & Sustainable Development)

Population Ecology: Individuals, Species, Population, Community

Human Population Growth, Population Control Methods

Urbanization and its effects on Society

Climate Change : Causes, effect, Global Warming, Carbon footprint and environmental protection

Steps taken towards sustainable development : Ban of single-use plastics, Automobile Scrapping Policy,

Promotion of Electrical Vehicles

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

UNIT – III (Disaster Management)

Disaster Management : Types of disasters (Natural and Man-made) and their causes and effect

Vulnerability Assessment and Risk Analysis : Vulnerability to various disasters (Flood, Cyclone, Earthquake, Heat waves 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)

Preparedness Measures : Disaster Management Cycle, 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, Fire, Earthquake, Cyclone, Lightning)

UNIT – IV

Brief idea on Epidemics and Pandemics

Non-communicable diseases with special reference to Cardiovascular diseases, Cancer, Diabetes, Hypertension and Obesity and their prevention

Communicable diseases with special reference to Covid-19, Flu, Hepatitis, AIDS and Tuberculosis and their transmission

Dynamics of Disease Transmission : Mode of transmission (Direct/Indirect), Events after infection: Immunity (Active vrs Passive, Innate vrs Acquired, Herd Immunity), Incubation Period

Prevention of Epidemics/Pandemics Diseases : Preventing Measures (Quarantine, Sanitization, Personal Protective measures such as hand washing and use of protective devices, Vaccination); Control Measures (Surveillance, Isolation, Contact Tracing)

Life Style management : Diet, Physical Exercise, Yoga and sleeping habit
Role of Different Sectors in Managing Health Disaster : Role of Government (Centre and State), Community, Civil Society, Student mass, NGOs

Books Recommended:

- ❖ Asthana DK and Asthana M : A Text Book of Environmental Studies, S. Chand, New Delhi.
- ❖ Bharucha E : A Text Book of Environmental Studies, New Delhi, UGC.
- ❖ Dash MC and Mishra PC : Man and Environment, McMillan, London.
- ❖ Disaster Management and Mitigation Plan, 2013 of Dept. of Health & Family Welfare, Govt. of Odisha*
- ❖ Mishra DD : *Fundamental Concept in Environmental Studies*, S. Chand, New Delhi.
- ❖ National Policy on Disaster Management, 2009*
- ❖ National Disaster Management Plan, 2019*
- ❖ Odeem EP, *Fundamentals of Ecology*, Natraj Publications.
- ❖ State Disaster Management Plan, 2019 of Government of Odisha*
- ❖ Standard Operating Procedure (SOP) issued by Govt. of India and Govt. of Odisha on Public Health Managements in the websites www.mohfw.gov.in and health.odisha.gov.in*
- ❖ The Disaster Mangement Act. 2005 of Government of India*

[Note : Star (*) marked Reference, published by the State as well as Central Government are available in the open sources]

AECC-1.5 (EV-I) : ETHICS & VALUES

UNIT-I : Issues Relating to Women

End Sem – 25 Marks

Full Marks – 25 Marks

1.1 Introduction:

General introduction on Ethics and Values, Gender equality as an essential precursor to social progress, the present scenario, Desirable gender related values

1.2 Women and Family:

Pre-natal sex selection, Gendered practices in the family, Gender based division of labour in the family, Marriage and women, Marriage and women's consent, Child marriage, Practice of dowry, Women and family violence

1.3 Women and Work:

Women's work: The Invisible hands, Exploitation of women at work, Gender Stereotyping at work, Glass Ceiling, Women and pay gap, Sexual Harassment of women at work, Working women and role conflict

1.4 Women, Community and Society:

Violence against women in public spaces, Gender sensitive language and communication, Gendered language, Sexist Language, Gender neutral language, Women and property Rights, Women's property Rights in Indian Laws, The functionality of Women's Property Rights

SEMESTER-II

C-2.1 : MYCOLOGY AND PHYTOPATHOLOGY

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives

Learn about structure, pigmentation, food reserve, method of reproduction and economics importance of fungi and lichen.

To study about living, non-living and environmental causes of plant diseases.

THEORY

UNIT-I

- i. Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.
- ii. Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus*.
- iii. Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, and *Neurospora*.
- iv. Basidiomycota: General characteristics; Ecology and Classification; Life cycle of *Puccinia* and *Agaricus*.

UNIT-II

- i. Allied Fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.
- ii. Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora*, and *Albugo*.
- iii. Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction. Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance. Economic importance of Lichens.

UNIT-III

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

UNIT-IV

Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host- Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton. Viral diseases – Tobacco Mosaic, Vein Clearing. Fungal diseases – Early blight of potato, Loose and covered smut.

PRACTICAL

- i. Introduction to the world of fungi (Unicellular, coenocytic/ septate mycelium, ascocarps & basidiocarps).
- ii. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
- iii. *Aspergillus*, *Penicillium* and *Saccharomyces* : study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
- iv. *Puccinia* : Study of different stages from temporary mounts and permanent slides.
- v. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, and fairy rings are to be shown.
- vi. *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
- vii. *Phytopathology*: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: Mosaic disease of ladies finger, papaya, cucurbits, moong, black gram, Fungal diseases: Blast of rice, Tikka disease of ground nut, powdery mildew of locally available plants and White rust of crucifers.

Outcomes

- As simple eukaryotic organisms fungi are important model research organisms.
- Know about some plant diseases special reference to the causative agent, symptoms, etiology, and control majors.

Text Books:

1. Mishra, B. K. (2017), Mycology and Phytopathology, Kalynai Publishers, New Delhi.

Reference Books:

- ❖ Sharma, P. D. (2017). Mycology and Phytopathology Rastogi Publication, Meerut.
- ❖ Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
- ❖ Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
- ❖ Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
- ❖ Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
- ❖ Mehrotra, R. S.(2011). Plant Pathology. Tata Mc Graw-Hill Publishing Company Limited, New Delhi

C-2.2 : ARCHEGONIATAE

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives

Pteridophytes have been considering an excellent source of ornamental purposes. Gymnosperms are good source of food and seeds are used as edible spices.

THEORY

UNIT-I

- i. Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations. General characteristics; Origin of land plants and Adaptations to land habit;
- ii. Bryophytes : Origin and Classification; Range of thallus organization. Classification (up to family). Structure, Reproduction and evolutionary trends in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria* (developmental stages not included). Ecological and economic importance of bryophytes.

UNIT-II

Pteridophytes: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum*, *Pteris* and *Marsilea*. Apogamy, and apospory, heterospory and seed habit, telome theory, stellar evolution and economic importance.

UNIT-III

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

UNIT-IV

Palaebotany: Geological time scale, fossils and fossilization process. Morphology, anatomy and affinities of Rhynia, Calamites, Lepidodendron, Lyginopteris, Cycadeoidea and Williamsonia.

PRACTICAL

1. Morphology, anatomy and reproductive structures of *Riccia*, *Marchantia*, *Anthoceros*, *Funaria*.
2. *Psilotum*- Study of specimen, transverse section of synangium (permanent slide).
3. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
4. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
5. Study of temporary preparations and permanent slides of *Marsilea*.
6. *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
7. (vii)*Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll and megaspore, T.S root, leaflet, rachis
8. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), T.S. Needle, stem, L.S. male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), L.S. of female cone.
9. *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide).
10. Study of some fossil slides / photographs as per theory.

Outcomes

- Learn about general characters and classification, stellar evolution in pteridophytes and gymnosperms.
- Know about the structure life history, and economic importance of gymnosperm.
- Knowledge about fossils and methods of fossilization process.

Text Books:

1. Vasistha, B. R. (2017) Botany for Degree student, Bryophyta, S. Chand Publication, New Delhi.
2. Singh, V., Pandey, P.C. and Jain, D.K. (2017). Archegoniate, Rastogi Publication, Meerut.

Reference Books:

- ❖ Acharya, B. S. (2017), Archegoniate, Kalyani Publishers, New Delhi.
- ❖ Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. New Delhi, India.
- ❖ Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- ❖ Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

GE-2.3 : PLANT PHYSIOLOGY AND METABOLISM

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives

Concerns the physiological functions or processes of plants and to illustrates knowledge about molecular understanding of primary and secondary metabolic processes.

THEORY

UNIT-I

- i. Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.
- ii. Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.
- iii. Translocation in phloem.: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

UNIT-II

- i. Photosynthesis: Photosynthetic Pigments (*Chl a, b, xanthophylls, carotene*); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation.
- ii. Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative Phosphorylation.

UNIT-III

- i. Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.
- ii. Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

UNIT-IV

- i. Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.
- ii. Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on homomorphogenesis; Vernalization.

PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.

Outcomes

- Know about the requirements of mineral nutrition for plant growth.
- Know about the plant growth hormones.
- Acquire knowledge in various metabolic processes occurs in plants.

- Understand the basic knowledge about photosynthesis and respiration.

Text Books:

1. A. C. Sahu (2018). Plant Physiology and Metabolism. Kalyani Publishers, New Delhi.

Reference Books:

- ❖ Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- ❖ Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
- ❖ Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
- ❖ H. S. Srivatava. Plant Physiology, Rastogi Publications, New Delhi

AECC-2.5 (EV-II) : ETHICS & VALUES

UNIT-II : Values and Good Citizenship

End Sem – 25 Marks

Full Marks – 25 Marks

2.1 Indian Constitution:

Salient Values of Preamble : Sovereign, Socialist, Secular, Democratic, Republic, Justice, Liberty, Equality and Fraternity

2.2 Patriotism:

Patriotic value and ingredients of nation building, Concept of Good citizenship, Emotional connection with the country, Duties of citizens and Qualities of good citizens

2.3 Volunteerism:

Concept of facets of Volunteerism and Leadership, Building a better society through Volunteerism, Blood Donation, Social Work, Helping the Aged, Environmental Protection

2.4 Work Ethics:

Punctuality, Cleanliness, Law abidingness, Rational Thinking and Scientific Temper

SEMESTER-III

C-3.1 : ANATOMY OF ANGIOSPERMS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

It emphasizes different part of tissue and tissue system and various adaptive features justifying ecotypes.

THEORY

UNIT-I

- Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy.
- Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Cell wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.

UNIT-II

- Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cyto-histological zonation); Types of vascular bundles; Anatomy of dicot and monocot stem. Vascular Cambium: Structure, function and seasonal activity of cambium; secondary growth in stem (normal and anomalous). Root Stem transition.
- Leaf: Anatomy of dicot and monocot leaf, Kranz anatomy.

UNIT-III

- Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Anatomy of dicot and monocot root; Endodermis, exodermis and origin of lateral root. Secondary growth in roots.
- Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.
- Periderm: Development and composition of periderm, rhytidome and lenticels.

UNIT –IV

- Adaptive and Protective Systems Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular: two examples of each), stomata (classification); Anatomical adaptations of xerophytes and hydrophytes.
- Secretory System: Hydathodes, cavities, lithocysts and laticifers.
- Mechanical tissue system.

PRACTICAL

- Study of distribution and types of parenchyma, collenchyma and sclerenchyma, Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres, Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
- Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
- Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
- Root: monocot, dicot, secondary growth.
- Stem: monocot, dicot - primary and secondary growth (normal and anomalous); periderm; lenticels.
- Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
- Ecological anatomy.

Outcomes

- Learn about the structure, chemistry and functions of cellular organelles.
- Understand the structural adaption of plants with respect to diverse environmental condition.
- Know about structure of plant tissue and their modification.

Text Books:

- Singh, V., Pandey, P.C. and Jain, D.K. (2017). Anatomy of Angiosperms, Rastogi Publication, Meerut.

Reference Books:

- ❖ Eames, A.J. and Mc Daniels, L.H., (1953). An introduction to plant anatomy, Tata Mc Grow Hills, New Delhi
- ❖ Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
- ❖ Tayal, M. S. (2012) Plant Anatomy Rajpal and Sons, New Delhi
- ❖ Mishra, B. K. (2017). Anatomy of Angiosperms, Kalyani Publishers, New Delhi.
- ❖ Pandey, B. P. (2017) Plant Anatomy, S. Chand Publication, New Delhi.

C-3.2 : ECONOMIC BOTANY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

It encompasses economic importance of crop plants, pulses, oil seeds etc. and its agricultural practices.

THEORY

UNIT-I

- i. Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.
- ii. Cereals: Cultivation and brief account of Wheat, Rice and millets.
- iii. Legumes: General account, importance to man and ecosystem.
- iv. Sugars & Starches: Morphology, cultivation and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, cultivation, propagation & uses.

UNIT-II

- i. Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper Beverages: Tea, Coffee (morphology, processing & uses)
- ii. Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis.
- iii. Tobacco: Tobacco (Morphology, processing, uses and health hazards)

UNIT-III

- i. Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* (Botanical name, family & uses)
- ii. Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

UNIT-IV

- i. Natural Rubber: Para-rubber: tapping, processing and uses.
- ii. Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers, Cotton and Jute (morphology, extraction and uses).

PRACTICAL

1. Cereals: Rice (habit sketch, study of paddy and grain, starch grains).
2. Legumes: Soya bean/moong bean/black gram, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, starch grains, micro-chemical tests).
4. Spice and Beverages: clove, black pepper, Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
5. Oils & Fats: Groundnut, Mustard-plant specimen, seeds; tests for fats in crushed seeds.
6. Drug-yielding plants: Specimens of *Digitalis*, *Papaver* and *Cannabis*.
7. Woods: *Tectona*, *Pinus*/Sal: Specimen, Section of young stem.
8. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Outcomes

- Learn about economic products with special reference to botanical name, family, morphology of useful part and uses.
- Find ways that will allow the plant to be used sustainably.
- Increase the economic benefits of crop plant.

Text Books:

1. B. P. Pandey, (2017) Economic Botany. S. Chand Publication, New Delhi.

Reference Books:

- ❖ Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
- ❖ Samba Murty, A.V.S.S. and Subrahmanyam, N.S. (2011). Text Book of Modern Economic Botany, CBS Publishers and Distributors, New Delhi.
- ❖ Hill, Albert F. Economic Botany, Tata Mc Grow Hill Publishing Company, Ltd. New Delhi.
- ❖ Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
- ❖ Singh, V., Pandey, P.C. and Jain, D.K. (2017). Economic Botany, Rastogi Publication, Meerut.
- ❖ Baruah, B. (2017). Economic Botany, Kalyani Publishers, New Delhi.

C-3.3 : GENETICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

It focuses on transfer of information to different generation, hereditary changes and inheritance.

THEORY

UNIT-I

- i. Mendelian genetics and its extension Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Interaction of genes, Pleiotropy, Recessive and Dominant traits, Polygenic inheritance.
- ii. Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; cytoplasmic male sterility; Maternal effect shell coiling in snail; Infective heredity- Kappa particles in Paramecium.

UNIT-II

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

UNIT-III

- i. Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy
- ii. Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms.

UNIT-IV

- i. Fine structure of gene: Classical vs. molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.
- ii. Population and Evolutionary Genetics: Gene pool, Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

PRACTICAL

1. Analysis of allelic and genotypic frequencies.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Chromosome anomaly : Translocation Ring, Laggards and Inversion Bridge, break etc (through photographs).

Outcomes

- Learn about Mendelian principles.
- Know about gene mapping method and extra chromosomal inheritance.

Text Books:

1. Singh B. D. (2017). Fundamental of Genetics, Kalyani Publishers, New Delhi.
2. Gupta P. K. (2017). Genetics, Rastogi Publication, Meerut.

Reference Books:

- ❖ Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & Sons, India. 8th edition.
- ❖ Sinnot, E.W., Dunn, L.C. and Dobzhansky, T. (1985) Principles of Genetics, Tata Mc Grow Hill, New Delhi
- ❖ Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
- ❖ Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W.H. Freeman and Co., U.S.A. 10th edition.
- ❖ Strickberger, M.W. Genetics, Pearson Publishers, 3rd Edition
- ❖ Rastogi V. B. (2017). Genetics, Kedar Nath & Ram Nath, Meerut

AECC-3.6 (EV-III) : ETHICS & VALUES

UNIT-III : Issues of Drug, Tobacco and Alcohol Addiction

End Sem – 25 Marks

Full Marks – 25 Marks

3.1 Extent of the Problem:

Extent of Drug and Tobacco addiction and alcoholism in India, Myths associated with them, Health hazards associated with them and how they have become silent killers

3.2 Socio-economic impact:

Socio-economic impact of Drug and Tobacco addiction and alcoholism:

Loss of physical and mental strength, Loss of character, Loss of family ties and relationship, Loss of earning and livelihood potentials, Loss of societal respect and dignity etc

3.3 Laws to Address this Problem:

Silent features of social legislation such as NDPS Act, 1985 and COTPA Act, 2003, Mechanism and Government Schemes for prevention, deaddiction and rehabilitation

3.4 Role of Stake - holders:

Provision of Tobacco free campus and role of students, Role of students in their family and immediate surroundings, Role of NGOs and other agencies

SEMESTER-IV

C-4.1 : MOLECULAR BIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

This course emphasizes the molecular mechanism of DNA replication, repair, protein synthesis etc.

THEORY

UNIT-I

Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty), Types of genetic material, denaturation and renaturation, cot curves. Organization of DNA and structure of RNA- Prokaryotes, Viruses, Eukaryotes, Fraenkel-Conrat's experiment. Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome -Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

UNIT-II

- i. The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5' end of linear chromosome; Enzymes involved in DNA replication. (ii) Central dogma and genetic code: Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)
- ii. Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail); Ribozymes, exon shuffling; RNA editing and mRNA transport.

UNIT-III

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

UNIT-IV

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

PRACTICAL

1. Preparation of LB medium and raising *E. coli*.
2. Isolation of genomic DNA from suitable plant material.
3. RNA estimation by orcinol method.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
6. Study of Barr body from buccal smear preparation.

Outcomes

- Learn about the core principles of molecular biology.
- Know about the large and overarching discipline.
- Increase the higher level of thinking skills at molecular level.

Text Books:

1. Gupta P. K. (2017). Molecular Biology, Rastogi Publication, Meerut.

Reference Books:

- ❖ Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
- ❖ Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
- ❖ Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
- ❖ Sheeler, P. and Bianchi, D.E. (2009) Molecular Biology of the Cell, Willey Publisher, New Delhi

- ❖ Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W.H. Freeman and Co., U.S.A. 10th edition.
- ❖ Alberts, B. et al. 2014. Molecular Biology of the cell Garland Science. 6th Edition
- ❖ Power, C. B. (2017) Cell Biology, Himalaya Publishing House, New Delhi
- ❖ Sahu, A.C. (2017). Essentials of Molecular Biology, Kalyani Publishers, New Delhi.

C-4.2 : PLANT ECOLOGY & PHYTOGEOGRAPHY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

The course describes classification of plant community in terms of climatic conditions, plant succession and establishment of plant community.

THEORY

UNIT-I

- i. Introduction Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environment, concept of hydrosphere and lithosphere and dynamism, homeostasis.
- ii. Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

UNIT-II

- i. Soil: Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.
- ii. Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

UNIT-III

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

UNIT-IV

- i. Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.
- ii. Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.
- iii. Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Phytogeographical division of India; Vegetation of Odisha.

PRACTICAL

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
3. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
4. Study of morphological adaptations of hydrophytes, xerophytes, halophytes (two each).
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
6. Quantitative analysis of herbaceous vegetation for frequency, density and abundance in the college campus.
7. Field visit to familiarize students with ecology of different sites.

Outcomes

- Learn about the approaches to the study of ecology (autoecology and synecology).
- Understand the population and community ecology.

Text Books:

1. Sharma, P.D. (2017). Fundamentals of Ecology. Rastogi Publications, Meerut, India.

Reference Books:

- ❖ Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
- ❖ Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.

- ❖ Wilkinson, D.M. (2007). *Fundamental Processes in Ecology: An Earth Systems Approach*. Oxford University Press. U.S.A.
- ❖ Kormondy, E.J. (1996). *Concepts of ecology*. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
- ❖ Santra, S. C. (2015) *Environmental Science*. New Central Book Agency (P) Ltd. Kolkata.
- ❖ Das M. C. and Das S. P. (2009). *Fundamental of Ecology*. Tata McGraw Hill, New Delhi.
- ❖ Shukla R.S. and Chandel P.S. (2016). *A Text Book of Plant Ecology*. S Chand Publication, New Delhi

C-4.3 : PLANT SYSTEMATICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

It allows the identification of unknown species and their classification by comparing them to known species.

THEORY

UNIT-I

Plant identification, Classification, Nomenclature; Biosystematics. Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access

UNIT-II

Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

UNIT-III

- i. Systematics- an interdisciplinary science: Evidence from palynology, cytology, phytochemistry and molecular data.
- ii. Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (up to series) and Hutchinson (up to series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

UNIT-IV

Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin & evolution of angiosperms; co- evolution of angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). Families of Angiosperms : Descriptive studies of Magnoliaceae, Rosaceae, Rubiaceae, Poaceae, Orchidaceae, Musaceae, Acanthaceae, Apocynaceae, Asclepiadaceae, Lamiaceae.

PRACTICAL

1. Study of vegetative and floral characters of available materials of the families included in theory syllabus (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).
2. Field visit, plant collection and herbarium preparation and submission. Mounting of properly dried and pressed specimen of at least fifteen wild plants with herbarium label (to be submitted in the record book)

Outcomes

- Learn about the type of classification- artificial, natural, and phylogenetic.
- Knowledge about herbarium techniques.
- Learn about the taxonomic evidences from cytology, molecular biology and cytochemistry.

Text Books:

1. Sharma O. P. (2009) *Plant Taxonomy*, Tata Mc Grow Hill, New Delhi

Reference Books:

- ❖ Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
- ❖ Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge.
- ❖ Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). *Plant Systematics-A Phylogenetic Approach*. Sinauer Associates Inc., U.S.A. 2nd edition.
- ❖ Saxena, H. O. and Brahman, M. *The Flora of Orissa*, CSIR Publication.
- ❖ Bose T. K. (2009). *Trees of the World*, Regional Plant Resource Centre, Bhubaneswar, Odisha, India
- ❖ Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.

- ❖ Hanes, H. H. (2009). Botany of Bihar and Orissa,
- ❖ Mohanty, C. R. (2017). Text Book of Plant Systematics, Kalyani Publisher, New Delhi.
- ❖ Subrahmainayam, M. S. (2011) Modern Plant Taxonomy, Vikash Publishing House, New Delhi
- ❖ Pandey, B. P., (2017). Taxonomy of Angiosperm. S. Chand Publication.

GE-4.4 : PLANT ECOLOGY AND TAXONOMY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

The course describes classification of plant community in terms of climatic conditions and allows the identification of unknown species and their classification.

THEORY

UNIT-I

- i. Ecological factors: Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes
- ii. Plant communities : Characters; Ecotone and edge effect; Succession; Processes and types

UNIT-II

- i. Ecosystem : Structure; Biotic and abiotic components, energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous
- ii. Phytogeography: Principal biogeographical zones, Endemism.

UNIT-III

- i. Introduction to plant taxonomy: Identification, Classification, Nomenclature.
- ii. Identification : Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

UNIT-IV

- i. Taxonomic hierarchy: Ranks, categories and taxonomic groups
- ii. Botanical nomenclature: Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.
- iii. Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Hutchinson (upto series).
- iv. Taxonomic description of the families : Malvaceae, Fabaceae, Asteraceae and Poaceae, Apocynaceae, Lamiaceae and Musaceae.

PRACTICAL

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
7. Study of vegetative and floral characters of the families as in theory syllabus (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).
8. Mounting of properly dried and pressed specimen of any ten wild plant's with herbarium label (to be submitted in the record book).

Outcomes

- Learn about the approaches to the study of ecology (autecology and synecology).
- Know about the type of classification- artificial, natural, and phylogenetic.

Text Books:

1. Sharma, P.D. (2017). Fundamentals of Ecology. Rastogi Publications, Meerut, India.

Reference Books:

- ❖ Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
- ❖ Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
- ❖ Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
- ❖ Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
- ❖ Sahu, A. C. (2017). Plant Ecology and Phytogeography, Kalyani Publishers, New Delhi.
- ❖ Das, M. C. and Das, S. P. (2009). Fundamental of Ecology. Tata McGraw Hill, New Delhi.
- ❖ Shukla, R.S. and Chandel, P.S. (2016). A text book of Plant Ecology. S Chand Publication, New Delhi
- ❖ Mohanty, C. R. (2017). Text Book of Plant Systematics, Kalyani Publisher, New Delhi.

AECC-4.6 (EV-IV) : ETHICS & VALUES

UNIT-IV : Ethical Values for Student Life

Full Marks – 25
End Sem – 25/1 hr

4.1 Meaning and Objective of Education :

Knowledge is power and quest for knowledge is the real meaning of education, not quest for Degree and qualifications; Real education builds character : Difference between Academic Qualification and Ability, Academic failure could be failure within the classroom, but not outside (i.e. Failed in exam, passed in life!)

4.2 Challenges for Ethical Practices in Institutions of Higher Education:

Ragging, Suicide and Need for Educational Counseling, Violence vs. Peaceful Protest, Conflict resolution, Plagiarism and violation of Intellectual property Rights, Cheating in Examination and other Fraudulent Practices

4.3 Inter personal Relation and Community Life in HEI :

Green Preacher and conservation of Energy, Community Life in Campus including Hostels, Local Common area, Inter personal relations (Students-Teacher, Students-Student and Man-Woman, Positive Friendship)

4.4 Ethical Leadership in Academic Institution :

Concept and Traits of Leadership to Provide solution, everyone has Leadership Role (not limited to position), Concept of Ethical leadership, Scope of Leadership in college and Universities for Students, Teachers and Administrators, Importance of Co-curricular and extra-curricular activities.

SEMESTER-V

C-5.1 : REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives

This course aims to impart and insight into the internal structure and development of reproductive organs of most evolved group of plants.

THEORY

UNIT-I

- i. Introduction: History and scope.
- ii. Anther: Anther wall: Structure and functions, micro-sporogenesis, callose deposition and its significance.
- iii. Pollen biology: Micro-gametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

UNIT-II

Ovule: Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– mega-sporogenesis and mega-gametogenesis; Types and ultrastructure of different mature embryo sacs (Details of *Polygonum* type), Developmental pattern of mono-, bi- and tetrasporic embryo sacs.

UNIT-III

- i. Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.
- ii. Self incompatibility: Basic concepts; Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and *in vitro* pollination; Modification of stigma surface.

UNIT-IV

- i. Endosperm: development, structure and functions
- ii. Embryo: Types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo- endosperm relationship; Nutrition of embryo; Embryo development in *Paeonia*.
- iii. Seed: Structure, importance and dispersal mechanisms
- iv. Polyembryony and apomixes: Introduction; Classification; Causes and applications.

PRACTICAL

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ UNIT (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test, Germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, UNTegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). Female gametophyte through permanent slides/photographs: Types, ultrastructure of mature egg apparatus.
5. Embryogenesis: Study of development of dicot embryo through permanent slides/photographs; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.
6. Tracing the path of pollen tube.
7. Study of haustorial endosperm.

Outcomes

- Learn about male and female reproductive organ of flower.
- Learn about double fertilization and its significance.
- Know about the structure and development of monocot and dicot embryo.

Text Books:

1. Singh, V., Pandey, P.C, and Jain, D.K. (2017). Reproductive Biology of Angiosperms, Rastogi Publications, Meerut

Reference Books:

- ❖ Maheswari, P. (2009). Embryology of Angiosperms.
- ❖ Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
- ❖ Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
- ❖ Johri, B.M. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
- ❖ Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
- ❖ Mishra, B. K. (2017). Reproductive Biology of Angiosperms, Kalyani Publishers, New Delhi.

C-5.2 : PLANT PHYSIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

Concerns the physiological functions or processes of plants.

THEORY

UNIT-I

- i. Plant water relationship: Water Potential and its components, plasmolysis and imbibitions, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, trans-membrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.
- ii. Translocation in the phloem: Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

UNIT-II

- i. Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.
- ii. Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, and antiport.

UNIT-III

Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Brassinosteroids and Jasmonic acid.

UNIT-IV

- i. Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Senescence: Types and causes.
- ii. Phytochrome: Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the induction of amylase activity in germinating barley grains
8. To demonstrate suction due to transpiration.
9. Measurement of relation between transpiration and transpiring surface.
10. Measurement of cuticular resistance to transpiration.

Outcomes

- Know about the requirements of mineral nutrition for plant growth.
- Understand the processes of photosynthesis, respiration, nitrogen metabolism.
- Know about the plant growth hormones.

Text Books:

1. Sinha, R. K. (2015). Modern Plant Physiology, Narosa Publishing House, New Delhi.

Reference Books:

- ❖ Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
- ❖ Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- ❖ Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
- ❖ Salisbury, F. B. and Ross, C. W. Plant Physiology Wadsworth Publishing Company, California
- ❖ Sahoo, A. C. (2018). Outlines of Plant Physiology Kalynai Publishers, New Delhi.
- ❖ Srivastava, N. K.. (2017). Plant Physiology, Rastogi Publications, Meerut.
- ❖ Pandey and Sinha (2011). Plant Physiology, Vikash Publishing House, New Delhi

DSE-5.3 : ANALYTICAL TECHNIQUES IN PLANT SCIENCES

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives

This course especially designed for skill development of the students of plant science by acquiring knowledge of plant analytical technique.

THEORY

UNIT-I

Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Flow cytometry (FACS); Transmission and Scanning electron microscopy –sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

UNIT-II

Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment. Spectrophotometry: Principle and its application in biological research.

UNIT-III

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography. Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

UNIT-IV

Biostatistics: Statistics, data, population, samples, variables, parameters; Representation of Data: Tabular, Graphical; Measures of frequency and central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variance, standard deviation; Chi-square test for goodness of fit. Test of significance: comparison of large, small and paired samples (T-Test) and correlation.

PRACTICAL

1. Study of different microscopic techniques for chromosome study
2. Study of PCR Demonstration.
3. To separate pigments by paper chromatography.
4. To separate phytochemicals by thin layer chromatography.
5. To estimate protein through Lowry's methods.
6. To separate proteins using PAGE.
7. To separate DNA (marker) using AGE.
8. Spectrometric estimation of total sugar by Anthrone method.
9. Chi-square analysis of mendelian ratio.
10. T-Test.

Outcomes

- Provides the foundation for studying microscopy.
- Understand the basic mechanism of centrifugation.
- Learn about the use of radioisotope in biological research.
- Know about the separation of particles by using different chromatographic technique.

- Analyses the samples by t-test and Chi-square test.

Text Books:

1. Patil, C. S. (2017). Advanced Analytical Techniques, ABE Books, New Delhi.

Reference Books:

- ❖ Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
- ❖ Ruzin, S.E. (1999). Plant Micro technique and Microscopy, Oxford University Press, New York. U.S.A.
- ❖ Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
- ❖ Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.
- ❖ Aneja, K. R. (2014). Laboratory manual of microbiology and biotechnology, Medtech, New Delhi

DSE-5.4 : NATURAL RESOURCE MANAGEMENT

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

This course focuses on various types of natural resource management, and its sustainable use.

THEORY

UNIT-I

- i. Natural resources: Definition and types.
- ii. Sustainable utilization : Concept, approaches (economic, ecological and sociocultural).
- iii. Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management.
- iv. Water: Fresh water (rivers, lakes, groundwater, water harvesting technology, rain water storage and utilization).

UNIT-II

Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan). Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.

UNIT-III

- i. Energy: Renewable and non-renewable sources of energy-solar, wind, tidal, geothermal and bioenergy resources.
- ii. Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint.

UNIT-IV

Resource Accounting; Waste management. National and international efforts in resource management and conservation

PRACTICAL

1. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) and its impact on land degradation.
2. Collections of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.
6. Estimation of soil moisture content and soil texture.
7. Estimation of soil porosity
8. Estimation of soil water-holding capacity.
9. Estimation of soil organic matter and soil carbon

Outcomes

- Provides the foundation for reserve management and sustainable use of natural resource.
- Concerns with the interaction of people and natural landscape.
- Identification the soil types, formation and way to modify soil structure.
- Know about rain water harvesting, storage and utilization.

Text Books:

1. Pandey, B. W. 2005. Natural Resource Management. Mittal Publication, New Delhi

Reference Books:

- ❖ Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
- ❖ Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
- ❖ Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

AECC-5.5 (EV-V) : ETHICS & VALUES

UNIT-V : Vulnerable Sections of Society: Understanding their Issues

Full Marks – 25
End Sem – 25/1 hr

5.1 Issues Relating to Children:

Nutrition and health, Child Exploitation : Child labour, Trafficking, Sexual exploitation

5.2 Issues Relating to Elderly Persons:

Abuse of Elders, Financial Insecurity, Loneliness and Social Insecurity, Health Care Issues, Needs for a Happy and Dignified Ageing

5.3 Issues Relatng to Persons with disability:

Rights of PWD, affirmative action, Prevention of discrimination, providing equal opportunity, various scheme for empowering PWD and social justice for PWD

5.4 Issues Relating to Third Gender:

Understanding the Third Gender, Social justice for them, Removal of discrimination, Affirmative action and Acceptance of diversity of gender

SEMESTER-VI

C-6.1 : PLANT METABOLISM

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

To illustrate knowledge about molecular understanding of primary and secondary metabolic processes.

THEORY

UNIT-I

- i. Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).
- ii. Mechanisms of signal transduction: Calcium, phospholipids, cGMP, NO.

UNIT-II

Carbon assimilation: Historical background, photosynthetic pigments, role of photosynthetic pigments, Red drop and Emerson Enhancement Effect, antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, C3, C4 pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction. Photorespiration.

UNIT-III

- i. Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanideresistant respiration, factors affecting respiration.
- ii. ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photo- phosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

UNIT-IV

- i. Lipid metabolism: Synthesis and breakdown of triglycerides, β -oxidation, glyoxylate cycle, gluco-neogenesis and its role in mobilisation of lipids during seed germination, α oxidation.
- ii. Nitrogen metabolism: Nitrate assimilation, free living and symbiotic biological nitrogen fixation (examples of legumes and non-legumes); Nitrification, Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and trans-amination.

PRACTICAL

1. Isolation and quantization of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. Demonstration of absorption spectrum of photosynthetic pigments.
7. Assay of the enzyme Catalase.
8. Photoreduction of dye by isolated chloroplasts.

Outcomes

- Acquire knowledge in various metabolic processes occurs in plants.
- Understand the basic knowledge about Carbon assimilation and oxidation.
- Learn about nitrogen fixation in legumes and non-legumes plants.
- Know about lipid in plant physiology and development.

Text Books:

1. Gupta, S, K. (2017). Plant Metabolism, Rastogi Publication, Meerut.

Reference Books:

- ❖ Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
- ❖ Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- ❖ Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
- ❖ Sahoo, A. C. (2018). Outlines of Plant Metabolism, Kalyani Publishers, New Delhi.

C-6.2 : PLANT BIOTECHNOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

To alter genetic information in organisms and produce improved varieties and to develop different product.

THEORY

UNIT-I

Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones). Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

UNIT-II

Recombinant DNA technology-I: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC, MAC, HAC). Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).

UNIT-III

Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, Methods of gene transfer- *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

UNIT-IV

Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

PRACTICAL

1. a) Preparation of tissue culture (MS) medium.
b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of another culture through photographs.
3. Preparation of artificial seeds.
4. Study of Bt cotton through photographs.
5. Isolation of plasmid DNA.
6. Gel electrophoresis (demonstration).

Outcomes

- Know about the role of tissues culture in crop improvement.
- Understand the basic knowledge about Recombinant DNA technology.
- Know about different transgenic crops with improved quality traits.
- Booming carrier option with high demand in different sectors.

Text Books:

1. Chawla, H. S. (2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Reference Books:

- ❖ Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- ❖ Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- ❖ Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
- ❖ Singh, B. D. (2018). Plant Biotechnology Kalyani Publishers, New Delhi.
- ❖ Gupta, P. K. (2017). Plant Biotechnology, Rastogi Publication, Meerut.
- ❖ Dubey, R. C. (2017). Advanced Biotechnology, S, Chand Publication, New Delhi

DSE-6.3 : HORTICULTURAL PRACTICES AND POST-HARVEST TECHNOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

Objectives

To increase the production and productivity of fruit, vegetable, ornamental crops, and its storage and protection from disease.

THEORY

UNIT-I

- i. Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.
- ii. Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (*Opuntia*, *Agave* and spurge)]

UNIT-II

- i. Fruit and vegetable crops: Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops.
- ii. Horticultural techniques: Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.
- iii. Landscaping and garden design : Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

UNIT-III

- i. Post-harvest technology: Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation;
- ii. Disease control and management : Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices;

UNIT-IV

Horticultural crops - conservation and management: Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

PRACTICAL

1. Identification and description of salient features of ornamental plants included in the syllabus.
2. Horticultural techniques (Drip irrigation, surface irrigation, furrow and border irrigation).
3. Study of practice of asexual propagation methods (grafting, cutting, layering, budding)
4. Planning and layout of parks and avenues
5. Handling of harvested fruits, vegetables and cut flowers
6. Methods of fruit preservation
7. Basic tissue cultures technique

Outcomes

- Gain knowledge about transfer technology from lab to land.
- Learn about preserve the essential characteristics of plants.
- Produce high yielding variety of fruit, vegetables etc.
- Conservation of different horticultural crops.
- Protection of the plant its product before and after harvesting.

Text Books:

1. Peter, K. V. (2009). Basics of Horticulture, Kalyani Publishers, New Delhi.

Reference Books:

- ❖ Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
- ❖ Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.

- ❖ NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
- ❖ Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
- ❖ Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.
- ❖ Pandey, P. H. (2007). Principles and Practices of Post Harvest Technology, Kalyani Publishers, New Delhi.

DSE-6.4 : INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

Full Marks – 100

Mid Sem – 15/1hr

End Sem Theory – 60/3 hrs

End Sem Practical – 25/3 hrs

Objectives

Application of microorganisms to produce different industrial products and use them to check environmental quality.

THEORY

UNIT-I

- i. Scope of microbes in industry and environment: Bioreactors/Fermenters and fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors- laboratory.
- ii. Microbial production of industrial products: Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.

UNIT-II

Microbial enzymes of industrial interest and enzyme immobilization: Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

UNIT-III

Microbes and quality of environment: Distribution of microbes in air; Isolation of microorganisms from soil, air and water. Microbial flora of water: Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality.

UNIT-IV

Microbes in agriculture and remediation of contaminated soils: Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

PRACTICAL

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media
3. Screening microorganisms for industrial use.
4. Mycorrhiza, arbuscular mycorrhizal colonization in plant roots
5. Determination of BOD, COD, TDS and TOC of water samples;
6. Microorganisms as indicators of water quality

Outcomes

- Learn about fermenters and fermentation process.
- Understand the basic knowledge about downstream processing.
- Learn about distribution of microbes in air, water and soil.
- Learn about microbial remediation of contaminated soil.

Text Books:

1. P. D. Sharma. (2017) Environmental Microbiology. Rastogi Publications, Meerut.

Suggested Readings

- ❖ Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
- ❖ Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

- ❖ Pradipta K. Mohapatra (2008). Text Book of Environmental Microbiology, I.K. International Publishing House, New Delhi
- ❖ A. K. Rath (2018). Industrial and Environmental Microbiology, Kalyani Publishers, New Delhi.

OR

DSE-6.4 : DISSERTATION / PROJECT WORK

Full Marks – 100
End Sem Project– 100

Identification of problem	Review of Literature	Methodology	Findings	Analysis	Viva-Voce	Total
10	10	10	25	25	20	100

** = Students who score more than $\geq 60\%$ in aggregate are eligible for project work

AECC-6.5 (EV-VI) : ETHICS & VALUES

UNIT-VI : Environmental & Techno Ethics

End Sem – 25 Marks
Full Marks – 25 Marks

6.1 Environmental Ethics:

Types of Ecological Values, Environmental Values & Valuing Nature, Equitable use of Resources, Role of Individual in the conservation of resources for future generation, Bio-Ethics-Genetic manipulation in plants and animals for benefits of society and cruelty against animal.

6.2 Promotion of Green Technology:

Goal of Green Technology: Reduce recycling, **Renew** (removal of chemicals),

Refuse and Responsibility.

Green Technology in relation to :- Energy and Construction.

6.3 Ethics and Technology:

Ethics and Technology with reference to Science, gadget, machine etc. and interaction with each other,

Agricultural, Industrial, Digital, Globalized Age etc

6.4 Judicious Use of Technology:

Judicious use of Mobile Phones, Electrical machines, Plastics, Television, Computers and their harmful effects

Ethics and Use of Digital Technology: Cyber ethics- Crimes and Ethical hacking,

Ethics of social media: WhatsApp, Facebook, Twitter and others

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