RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE

RAHARA, KOLKATA, WEST BENGAL
www.rkmvccrahara.org

DEPARTMENT OF BOTANY

PROGRAMME OFFERED: B.Sc. BOTANY HONOURS

PROGRAMME CODE: UGBOT

DURATION: 6 SEMESTERS

TOTAL CREDIT: 140

The CBCS curriculum in Botany is introduced from 2017 - 2018 onwards

with 61% revision vide BOS resolution dated 03.07.2017

2017

Choice Based Credit System (CBCS):

The choice-based credit system (CBCS) offers students to opt for courses of their choice – comprising of the core courses, elective courses, generic electives, skill-based courses & ability enhancement courses. The CBCS grading pattern is based on the earned credits every semester.

1) **Core Course (CC)**: A discipline specific compulsory basic course.
2) **Discipline Specific Elective Course (DSE)**: A discipline specific elective course which is more advanced or specialized.
3) **Generic Elective Course (GE)**: An inter-disciplinary elective course to be opted from a discipline other than one main discipline(s) of choice (e.g., a course other than in which honours has been taken).
4) **Skill enhancement Course (SEC)**: A discipline specific elective skill enhancement course.
5) **Ability Enhancement Compulsory Course (AECC)**: A compulsory course that may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

Credit Structure & Classes

In CBCS, all courses have credits assigned to them. The credit structure is described below:

Course Type	Theory + Practical		Vocational or Theory	Total Credit
	Theory	Practical		
CC	4	2		6
DSE	4	2		6
SEC			2	2
GE	4	2		6
AECC			2	2

Duration of the Semesters: The semesters will comprise **15-18 weeks of direct teaching.**

B.Sc. Honours – Semester wise courses

The number of courses to be taken in the different semesters have been specified in the table below.

	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Total	Credits
CC	2	2	3	3	2	2	14	14×6 = 84
DSE	-	-	-	-	2	2	4	4×6 = 24
SEC	-	-	1	1	-	-	2	2×2 = 4
GE	1	1	1	1	-	-	4	4×6 = 24
AECC	1	1	-	-	-	-	-	2×2 = 4
Total	4	4	5	5	4	4	26	**140**

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List of Core Courses (CC):

Sl. No.	Course Code	Course Name	Semester
1.	UGBOTCC01	Phycology and Microbiology	SEM-I
2.	UGBOTCC02	Biomolecules and Cell Biology	
3.	UGBOTCC03	Mycology and Phytopathology	SEM-II
4.	UGBOTCC04	Archegoniate	
5.	UGBOTCC05	Anatomy of Angiosperms	SEM-III
6.	UGBOTCC06	Economic Botany	
7.	UGBOTCC07	Genetics	
8.	UGBOTCC08	Molecular Biology	SEM-IV
9.	UGBOTCC09	Plant Ecology and Phytogeography	
10.	UGBOTCC10	Plant Systematics	
11.	UGBOTCC11	Reproductive Biology of Angiosperms	SEM-V
12.	UGBOTCC12	Plant Physiology	
13.	UGBOTCC13	Plant Metabolism	SEM-VI
14.	UGBOTCC14	Plant Biotechnology	

Note: All the Core Courses are compulsory for the Botany Honours students.

List of Discipline Specific Elective (DSE) Courses:

Sl. No.	Course Code	Course Name	Semester
1.	UGBOTDSE01	Industrial and Environmental Microbiology	SEM-V
2.	UGBOTDSE02	Plant Breeding	
3.	UGBOTDSE03	Biostatistics	SEM-VI
4.	UGBOTDSE04	Applied Phycology	
5.	UGBOTDSE05	Research Methodology	

Note: ***Any two*** to be selected in SEM-VI from this list.

List of Skill Enhancement Courses (SEC)

Sl. No.	Course Code	Course Name	Semester
1.	UGBOTSEC01	Value Education and Indian Culture	SEM-III
2.	UGBOTSEC02	Online Course in collaboration with IIT Bombay	SEM-IV

List of Ability Enhancement Compulsory Course (AECC)

Sl. No.	Course Code	Course Name	Semester
1.	UGAECC01	English Communication	SEM-I
2.	UGAECC02	Environmental Science	SEM-II

List of Generic Elective (GE) Courses*

Sl. No.	Course Code	Course Name	Semester
1.	UGBOTGE01	Cryptogamic Botany	SEM-I
2.	UGBOTGE02	Biology of Vascular Plants	SEM-II
3.	UGBOTGE03	Plant Ecology, Anatomy and Embryology	SEM-III
4.	UGBOTGE04	Plant Physiology and Biotechnology	SEM-IV

***Note:** Offered to students other than Botany Honours.

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Semester Wise Course Distribution (B. Sc., Botany Hons.)

Semester	Course Code	Course Name	Credit	Total Credit
SEM-I	UGBOTCC01	Phycology and Microbiology	6×1	20
	UGBOTCC02	Biomolecules and Cell Biology	6×1	
	UGBOTGE01*	Cryptogamic Botany	6×1	
	UGAECC01	English Communication	2×1	
SEM-II	UGBOTCC03	Mycology and Phytopathology	6×1	20
	UGBOTCC04	Archegoniate	6×1	
	UGBOTGE02*	Biology of Vascular Plants	6×1	
	UGAECC02	Environmental Science	2×1	
SEM-III	UGBOTCC05	Anatomy of Angiosperms	6×1	26
	UGBOTCC06	Economic Botany	6×1	
	UGBOTCC07	Genetics	6×1	
	UGBOTSEC01	Value Education and Indian Culture	2×1	
	UGBOTGE03*	Ecology, Anatomy and Embryology	6×1	
SEM-IV	UGBOTCC08	Molecular Biology	6×1	26
	UGBOTCC09	Plant Ecology and Phytogeography	6×1	
	UGBOTCC10	Plant Systematics	6×1	
	UGBOTSEC02	Online Course in collaboration with IIT Bombay	2×1	
	UGBOTGE04*	Plant Physiology and Biotechnology	6×1	
SEM-V	UGBOTCC11	Reproductive Biology of Angiosperms	6×1	24
	UGBOTCC12	Plant Physiology	6×1	
	UGBOTDSE	Any two to be chosen from Sem-V DSE courses	6×2	
SEM-VI	UGBOTCC13	Plant Metabolism	6×1	24
	UGBOTCC14	Plant Biotechnology	6×1	
	UGBOTDSE	Any two to be chosen from Sem-VI DSE courses	6×2	
		Total Credit (Full Course)		**140**

* For other than Botany Honours students.

Total Credit to be earned by a student to complete B.Sc. Botany Hons. Programme: 140

- Marksheet after each semester will be given both with SGPA (Semester Grade Point Average) and detailed marks obtained by the examinee.
- Similarly, Marksheet after the final semester will be given with CGPA (cumulative grade point average) and detailed marks obtained by the examinee.

Calculation of SGPA = (Total Credit x Total Grade Point = Total Credit Point); Total Credit Points / Total Credits

Calculation of CGPA = (Total SGPA x Total Credits in each Sem.) / Total Credits earned in all the semesters

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Programme Outcomes (POs)

After completion of the B.Sc. Degree program, the students will be able to

PO No.	Program Outcomes	Cognitive Level
PO-1	Recognize the scientific tempers and attitudes, which in turn can prove to be beneficial for the society since the scientific developments can make a nation or society to grow at a rapid pace.	R
PO-2	Understand scientific knowledge and exchange ideas with other stakeholders; make people aware about sustainable utilization of resources with ethical approach.	U
PO-3	Understand and apply the issues of environmental contexts and sustainable development as a basic interdisciplinary concern.	U, Ap
PO-4	Create the ability to perform experiments and to analyze & interpret the obtained accurate results and thus gain the ability to solve problems, to involve in critical, independent, and creative thinking.	An, E, C
PO-5	Possess expertise to apply and formulate ideas which will provide them competitive advantage in pursuing higher studies from India or abroad; and seek jobs in academia, research or industries.	Ap, E
PO-6	Assemble the acquired in-depth knowledge of applied subjects towards the inculcation of professional and employment skills so that students can make a career and become an entrepreneur in diverse fields.	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Programme Specific Outcomes (PSOs)

After completion of the B.Sc. degree program in Botany, the students will be able to

PSO No.	Program Specific Outcomes	Cognitive Level
PSO1	Outline an all-round development, rolling out to be globally ready individuals competent enough in various analytical and technical skills.	R, U
PSO2	Understanding and development of basic concepts in various plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology.	U, Ap
PSO3	Analyze and create awareness of natural resources and their conservation to develop responsibility as a citizen towards their community and environment.	U, An, E
PSO4	Design and formulate theoretical and lab-based experiments to generate technical advancement in priority areas such as genetics, cell and molecular biology, plant systematics and biotechnology.	E, C
PSO5	Invent, test, interpret and apply problems of biological interest, conduct self-evaluation to enrich themselves through lifelong learning.	C

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CORE COURSES

Addition = 60%
Modification = 10%
Total change = 70%

Semester – I	
Course name	**Phycology and Microbiology**
Course code	**UGBOTCC01**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives
• Increase the understanding of basic classification and evolution of the living world.
• Aware the students about the nature and role of microorganisms (bacteria and viruses).
• Explain the structure, organization, physiology, reproduction of simple autotrophic forms – Algae
• Explain the ecological and economical aspects of algae, bacteria and viruses.
• Apply the knowledge to learn use of beneficial and control of pathogenic microorganisms.

Core Course I: Phycology and Microbiology

THEORY

Unit 1: Introduction to microbial world (7 lectures)

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

Unit 2: Viruses (7 lectures)

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

Unit 3: Prokaryotes (7 lectures)

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

Unit 4: Algae (10 lectures)

General characteristics; Ecology and distribution; Life cycle patterns; Cell structure and components; Cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; Methods of reproduction; Classification; criteria, system of Fritsch (up to class) and evolutionary classification of Lee (2008) (up to phylum); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar and M.O.P. Iyengar);Role of algae in the environment (Phycoremediation, algal toxins, productivity, mutualism and symbiosis;Commensalism),agriculture (bio-fertilizer), biotechnology and industry (biodiesel, SCP production).

Unit 5: Cyanophyta (6 lectures)

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction; Morphology and life-cycle of *Nostoc*.

Unit 6: Chlorophyta (8 lectures)

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

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Unit 7: Heterokontophyta and Rhodophyta (15 lectures)

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Vaucheria*, *Ectocarpus*, *Sargassum* and *Polysiphonia*. Cell structure and reproduction in Diatoms.

PRACTICAL

I. Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electronmicrographs of bacteria, binary fission, endospore, conjugation, root nodule
3. Gram staining.
4. Endospore staining with malachite green using the endospores taken from soil bacteria
5. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas*(electron micrographs), *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*, *Vaucheria*, *Ectocarpus*, *Sargassum* and *Polysiphonia*, through electron micrographs, temporary preparations and permanent slides.

Course Outcome: After completion of this course the student will be able to

Sl. No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Develop knowledge on the diversity, phylogeny, classification of algae.	R, U	PO1, PO2	PSO1
CO2	Understand the structure, role and infectious cycle of bacteria and viruses.	U, An	PO2	PSO2
CO3	Understand life cycles of different algal species.	U, An	PO2	PSO2
CO4	Explore the economically important algae.	Ap, An	PO5, PO6	PSO3
CO5	Gain knowledge on the beneficial & harmful bacteria and viruses.	E	PO4, PO5, PO6	PSO3, PSO4

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Suggested Readings

- Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
- Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
- Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization Aravali International, New Delhi.
- Campbell, N.A., Reece J.B., (2008).Biology, Pearson Benjamin Cummings, USA. 8th edition.
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Stanier, R. Y.(1987) General Microbiology, 5th edition, MacMillan, London.
- Madigan, M., Martinco, J.,Bender, K.,Buckly, D.&Stahl,D.(2015) Brock Biology Of Microorganisms, 14th edition, Pearson Education, USA.
- Tortora, G. J., Funke, B. R. & Case, C. L.(2011) Microbiology-An Introduction,11thEdition, Pearson.

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Addition = 45%.
Modification = 10%
Total Change = 55%.

Semester – I	
Course name	**Biomolecules and Cell Biology**
Course code	**UGBOTCC02**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:

- Provide foundation to the structure and functions of nucleic acids,carbohydrates, proteins and lipids.
- Explain the structure of cell components and their functions,genome and its organization.
- Make the students acquainted with various biochemical processes occurring within the cell.
- Provide knowledge on cell division, cellular organization and cell functioning in plants.

Core Course II: Biomolecules and Cell Biology

THEORY

Unit 1: Biomolecules (20 lectures)

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

Carbohydrates: Nomenclature & classification; Mono-; Di-; Oligo- and polysaccharides.

Lipids: Definition, major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids, Triacylglycerols: structure, functions and properties, Phosphoglycerides.

Proteins: Str. of amino acids; protein structure levels-primary, secondary, tertiary and quaternary.

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

Unit 2: Bioenergenetics (4 lectures)

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

Unit 3: Enzymes (6 lectures)

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes (IUBMB); Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced – fit theory), Michaelis – Menten equation, Lineweaver Burk Plot; Enzyme inhibition: Types; Factors affecting enzyme activity.

Unit4: The cell (4 lectures)

Cell as a unit of structure and function of living organism; Characteristics of prokaryotic and eukaryotic cells; Concept of RNA world; Origin of eukaryotic cell (Endosymbiotic theory).

Unit 5: Cell wall and plasma membrane (4 lectures)

Cell wall: Chemical nature, Growth, Ultrastructure and function of plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport (diffusion), endocytosis and exocytosis.

Unit 6: Cell Organelles (16 lectures)

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina; Eukaryotic chromosome; Molecular organization of chromatin: Nucleosome, heterochromatin- constitutive and facultative, significance of heterochromatization, euchromatin, Nucleolus: Ultrastructure and its role in ribosome biogenesis. Karyotype concept and its importance in Chromosome study.

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Special types of Chromosome: Polytene, B chromosome and lamp-brush chromosome

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filaments.

Chloroplast, mitochondria and microbodies: Structural organization; Functions. Semiautonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Rough ER: Structure, protein targeting and insertion in ER; Protein folding, processing; Smooth ER: Lipid synthesis, export of proteins, lipids and carbohydrates; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus, role in plant cell wall formation; Lysosomes – Structure and function.

Unit 7: Cell division (6 lectures)

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases (budding yeast).

PRACTICAL

1. Qualitative tests for carbohydrates, reducing and 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. Measurement of cell size by micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs(ppt)
7. Cytochemical staining of DNA(Feulgen) and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Study the effect of organic solvent and temperature on membrane permeability.
9. Study different stages of mitosis. Determination of Mitotic index.
10. Study of polytene chromosome from *Drosophila*.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Understand cell structures and function, along with molecules present in cells.	R, U	PO1, PO2	PSO1, PSO2
CO2	Understand the mechanism of cell cycle.	R, U	PO1, PO2	PSO1, PSO2
CO3	Focus on cellular components, nuclear & organellar genome, along with their regulatory role.	U, Ap, An	PO2, PO3	PSO3
CO4	Upgraded their analytical skills and instrumentation.	An, E, C	PO4, PO5	PSO4, PSO5
CO5	Acquire knowledge in designing experiment, statistical analysis, and interpretation of results.	C	PO5, PO6	PSO4, PSO5

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Suggested Readings

- Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
- Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Churchill Livingstone
- Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
- Nelson & Cox (2008) Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
- Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
- Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Edu Inc. 8th ed.
- Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th ed. Sinauer Associates.
- 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.

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Addition = 50%
Modification = 10%
Total change = 60%

Semester – II	
Course name	Mycology and Phytopathology
Course code	UGBOTCC03
Number of lectures	90 (Th: 60 + Pr: 30)
Credits	4 (Theory) + 2 (Practical) = 6
Marks	100

Course Objectives: This course aims to

Course Objectives:
• Provide basic knowledge about the fungi and lichens, their economical & ecological significance.
• Explain the structure, growth, food reserves, reproduction methods offungi.
• Aware the students about parasitic and mutualistic interactions between fungi and plants.
• Enlighten the students about the phylogeny and evolutionary concepts in fungi.
• Identify the common plant diseases and device control measures.

Core Course III: Mycology and Phytopathology

THEORY

Unit 1: Introduction to true fungi (6 lectures)

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification (Hawksworth 1995); Heterothallism in fungi.

Unit 2: Chytridiomycota and Zygomycota (5 lectures)

Characteristic features; Ecology and significance; Thallus organization; Reproduction; Life cycle with reference to *Synchytrium*, *Rhizopus*.

Unit 3: Ascomycota (10 lectures)

General characteristics (asexual and sexual fruiting bodies);Ecology; Life cycle and classification with reference to*Saccharomyces*, *Penicillium*, *Alternaria*, *Neurospora*and*Ascobolus*.

Unit 4: Basidiomycota (8 lectures)

General characteristics; Ecology; Life cycle & Classification with special reference to *Puccinia* (black stem rust of wheat); *Agaricus*;Bioluminescence; fairy rings; Mushroom Cultivation (*Pleurotus*&*Agaricus*).

Unit 5: Fungus like organisms (5 lectures)

1.**Slime molds**:General characteristics; Status of Slime molds; Classification; Occurrence; Types of plasmodia; Types of fruiting bodies; 2.**Oomycota:** General characteristics; Ecology; Status of oomycota; Life cycle and classification with reference to *Phytophthora*,*Albugo*.

Unit 7:Mitosporic fungi (2 lectures)

Occurrence and importance; Steps and significance of Parasexuality

Unit 8: Symbiotic associations (4 lectures)

Lichen-Occurrence; characteristics; Growth forms& thallus organization; Nature of association of algal & fungal partner; Reproduction; Mycorrhiza-types; Role in agriculture and forestry.

Unit 9: Applied Mycology (8 Lectures)

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

Unit 10: Phytopathology (12 lectures)

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Koch's postulates.

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Host-Pathogen relationships (With special reference to Aflatoxins, Phytoalexins, SAR, ISR), Disease cycle and environmental relation. Prevention and control of plant diseases (Physical, chemical & bio-control);Role of quarantine. **Bacterial diseases**- Citrus canker and Bacterial Blight of rice. **Viral** diseases – Tobacco Mosaic, Vein clearing. **Fungal** diseases – Early blight of potato, Late blight of potato, Black stem rust of wheat, Stem rot of jute.

PRACTICAL

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps andbasidiocarps)

2. *Rhizopus*: Study of asexual stage from temporary slide& sexual structures from permanent slides.

3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of sexual stage from teleomorphs of these fungi with the help of permanent slides/photographs.

4. *Ascobolus*: sectioning through ascocarp.

5. *Alternaria*: Specimens/photographs and temporary mounts.

6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; Sections/ mounts of spores on wheat and permanent slides of sections of leaf of both the hosts.

7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.

8. Study of phaneroplasmodium from actual specimens or photograph. Study of *Stemonitis* sporangia from photographs.

9. *Albugo*: Study of symptoms of plants infected with Albugo; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.

10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)

11. Phytopathology: **I**. Herbarium specimens of Bacterial diseases: Citrus canker, Bacterial blight of rice. Viral diseases: TMV, Vein clearing. Fungal diseases: Early blight of potato,Late blight of potato, Black stem rust of wheat and stem rot of jute.

II. Isolation of pathogen from diseased leaf; Inoculation of pathogen in healthy fruit.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Understand the classification, structure, role and infectious cycle of fungi.	R, U	PO1, PO2	PSO1, PSO2
CO2	Evaluate the impact of fungi in industrial processes.	U, Ap	PO2, PO3	PSO3
CO3	Know the procedures for mushroom cultivation.	Ap	PO2	PSO3
CO4	Identify plant diseases, their causes & importance in agriculture industry.	An, E	PO4, PO5	PSO3, PSO4
CO5	Apply acquired knowledge to control plant diseases.	C	PO5, PO6	PSO4, PSO5

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating

Suggested Readings

- Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
- Alexopoulos, CJ, Mims, CW, Blackwell, M (1996). Introductory Mycology, John Wiley & Sons. 4th ed.
- Webster, J. & Weber, R. (2007). Introduction to Fungi, Cambridge University Press, 3rd ed.
- Sethi, IK and Walia, SK (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
- Sharma, PD. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

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Addition = 35%.
Modification = 05%.
Total change = 40%.

Semester – II	
Course name	Archegoniate
Course code	UGBOTCC04
Number of lectures	90 (Th: 60 + Pr: 30)
Credits	4 (Theory) + 2 (Practical) = 6
Marks	100

Course Objectives: This course aims to

Course Objectives

- Provide knowledge about the diversity of bryophytes, pteridophytes and gymnosperms.
- Increase understanding on their classification, biology, adaptive mechanisms,and phylogeny.
- Highlight advances in developmental& reproductive habitsand evolution of seeds.
- Aware the students about the economic values of these plant communities.

Core Course IV: Archegoniate

THEORY

Unit 1: Introduction (4 lectures)

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

Unit 2: Bryophytes (6 lectures)

General characteristics; Modern concepts about organisms traditionally called bryophytes; Adaptations to land habit; Classification; Range of thallus organization.

Unit 3: Type Studies-Bryophytes (12 lectures)

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

Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit 4: Pteridophytes (6 lectures)

General characteristics; Modern concept about the organisms traditionally called pteridophytes. Classification; Early land plants (*Cooksonia* and *Rhynia*); Structural and anatomical features of *Lepidodendron* and *Calamites*; Life cycle patterns in homosporous and heterosporous forms.

Unit 5: Type Studies- Pteridophytes (14 lectures)

Classification (up to family), morphology, anatomy & reproduction of *Psilotum*, *Selaginella*, *Equisetum*,*Dryopteris*&*Pteris* (Developmental details not to be included); Apogamy, and apospory; Heterospory and seed habit; Telome theory; Stelar evolution; Ecological and economic importance.

Unit 6: Progymnosperm and Gymnosperm (18 lectures)

Progymnosperm: Discovery, General characteristics; Classification (up to class) with characters & examples (Sporne, 1975); Vegetative and reproductive features of *Archaeopteris*. Gymnosperm: General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); General characters of Pteridospermales, Cordaitales and Bennettitales; Ecological and economic importance; Reconstruction of *Williamsonia scwardiana*.

PRACTICAL

1.*Riccia* – Morphology of thallus. Vertical section of thallus showing sporophyte.

2.*Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, VSof thallus through Gemma cup, whole mount of Gemmae (all temporary slides); VS of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).

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3.*Anthoceros*-Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).

4.*Pellia, Porella*- Whole mount (Permanent slides/specimens/photograph).

5.*Sphagnum*- Morphology of plant, whole mount of leaf (permanent slide only).

6.*Funaria*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, spores (temporary slides); permanent slides showing antheridial and archegonial heads, LS of capsule (Permanent slide); Protonema (Permanent slide/photograph).

7.*Psilotum*- Study of specimen, transverse section of synangium (permanent slide).

8.*Selaginella*- Morphology, whole mount of leaf with ligule; TS of stem, L.S. of strobilus from permanent slides. Whole mount of microsporophyll and megasporophyll (temporary slides),

9. *Equisetum*- Morphology, transverse section of internode, LS of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (temporary slide).

10. *Pteris*- Morphology, TS of rachis, VS of sporophyll, whole mount of sporangium& spores (temporary slide), whole mount of prothallus with sex organs & young sporophyte (permanent slide).

11. *Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, TS of coralloid root,TS of rachis,VS of leaflet, VS of microsporophyll, whole mount of spores (temporary slides), LS of ovule (permanent slide),

12. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones),TS of Needle, TS of stem (permanent slide), LS of male cone (permanent slide), whole mount of microsporophyll, whole mount of Microspores (temporary slides), LS of female cone (permanent slide), tangential longitudinal section &radial longitudinal sections of stem (permanent slide).

13. *Gnetum*- Morphology (stem, male & female cones), TS of stem, VS of ovule (permanent slide)

14. Botanical excursions.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	To know about morphological, anatomical and developmental patterns in bryophytes to gymnosperms.	R, U	PO1, PO2	PSO1, PSO2
CO2	To know about the reproductive parts, mechanism of reproduction and life cycle patterns.	U	PO1, PO2	PSO1, PSO2
CO3	To understand stelar evolution and seed formation in pteridophytes.	U	PO1, PO2	PSO1, PSO2
CO4	Economic values of the lower plants.	Ap, E	PO3	PSO3
CO5	Observe and identify bryophytes, pteridophytes and gymnosperms& their internal structures.	C	PO4, PO5	PSO4

*R = remembering, U = understanding, Ap = applying, An = analyzing, E = evaluating, and C = creating

Suggested Readings

- Vashistha, PC, Sinha, AK, Kumar, A (2010). Pteridophyta. S. Chand. Delhi, India.
- Bhatnagar, SP &Moitra, A (1996). Gymnosperms. New Age International, India.
- Parihar, NS (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
- Vanderpoorten, A. &Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

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Addition = 70%
Modification = 05%
Total Change = 75%

Semester – III	
Course name	**Anatomy of Angiosperms**
Course code	**UGBOTCC05**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives
• Provide knowledge on the arrangement of tissue and cells in vascular plants.
• Impart knowledge on the characteristics of specialized cells and their components.
• Develop ideas on the adaptive & protective system of plants.

Core Course V: Anatomy of Angiosperms

THEORY

Unit 1: Introduction and scope of Plant Anatomy

Applications in systematics, forensics and pharmacognosy.

Unit 2: Structure and Development of angiospermic plant body **(6 Lectures)**

Internal organization of plant body: The three tissue systems, types of cells and tissues.Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Unit 3: Tissues **(12 Lectures)**

Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Unit 4: Apical meristems and Primary tissues **(15 lectures)**

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica- Corpus theory, Continuing meristematic residue, cytohistological zonation);Types of vascular bundles;Structure of dicot and monocot stem Origin,development and arrangement of leaves; Structure of dicot (Dorsiventral) and monocot(Isobilateral) leaf, Kranz anatomy; Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap. Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.

Unit5: Vascular Cambium and Wood **(12 Lectures)**

Structure, function and seasonal activity of cambium; Secondary growth in root and stem; Axially and radially oriented elements; Types of rays and axial parenchyma. Reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood; Tyloses. Dendrochronology; Development and composition of periderm, rhytidome and lenticels.

Unit 6: Adaptive and Protective Systems **(11 Lectures)**

Epidermal tissue system, cuticle, epi-cuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of each), stomata: classification; Anatomical adaptations of xerophytes and hydrophytes. Anomalous secondary growth in angiosperms.

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PRACTICAL

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens/photomicrographs with the help of suitable examples.

2. Apical meristem of root, shoot and vascular cambium.

3. Distribution and types of parenchyma, collenchyma and sclerenchyma.

4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.

5. Wood: ring porous, diffuse porous; tyloses; heart- and sapwood.

6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.

7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.

8. Root: monocot, dicot,secondary growth, anomalous secondary growth.

9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels; anomalous sec. growth.

10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).

11. Adaptive Anatomy: xerophytes, hydrophytes.

12. Secretory tissues: cavities, lithocysts and laticifers.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Understand structural & functional components of plants.	R, U	PO1, PO2	PSO1, PSO2
CO2	Compare, contrast and describe the various tissue systems in plants.	U, Ap, An	PO2, PO3	PSO2
CO3	Outline the process of secondary growth in plants.	U, An	PO4	PSO2
CO4	Outline the practical use of plant anatomy.	U, An	PO4, PO5	PSO4, PSO5
CO5	Design, carry out laboratory techniques in plant anatomy.	E, C	PO5, PO6	PSO4

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating

Suggested Readings

1.Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.

2.Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.

3.Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

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

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Addition = 100%

Semester – III	
Course name	**Economic Botany**
Course code	**UGBOTCC06**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Create an understanding about the use of plant resources to produce valuable products.
• Impart knowledge about the economic importance of various plants.
• Develop students' ability to think and create useful plant products.
• Enlighten the students about the opportunities for income and employment generation.

Core Course VI: Economic Botany

THEORY **Lectures: 60**

Unit 1: Origin of Cultivated Plants (6 lectures)

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.

Unit 2: Cereals (6 lectures)

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets

Unit 3: Legumes (6 lectures)

Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Unit 4: Sources of sugars and starches (4 lectures)

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato: morphology, propagation & uses.

Unit 5: Spices (6 lectures)

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper.

Unit 6: Beverages (4 lectures)

Tea, Coffee (morphology & uses)

Unit 7: Sources of oils and fats (10 lectures)

General description, classification, extraction, their uses and health implications: groundnut, coconut, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods& their uses.

Unit 8: Natural Rubber (3 lectures)

Para-rubber: tapping, processing and uses.

Unit 9: Drug-yielding plants (8 lectures)

Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*; Tobacco (Morphology, processing and uses).

Unit 10: Timber plants(3 Lectures)

General account with special reference of teak and pine.

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Unit 11:Fibers (4 lectures)

Classification based on the origin of firers: Cotton, Coir and Jute (morphology, extraction and uses)

PRACTICAL

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

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Understand economically important plants, their origin and morphology etc.	R, U	PO1, PO2	PSO1, PSO2
CO2	Gain knowledge about plant products and their biochemical nature and industrial applications.	U, Ap	PO2	PSO2
CO3	Get an idea about the industrial processing of economically important plant products.	Ap, An	PO3	PSO2
CO4	Understand scope and importance of indigenous medicinal science, medicinal plants & their therapeutic use.	U, An, E	PO4, PO5, PO6	PSO3
CO5	Enlighten the students about the opportunities for income and employment generation.	E, C	PO5, PO6	PSO4, PSO5

*R = remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Suggested Readings

1 Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

2 Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

3 Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.

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Semester – III

Course name	**Genetics**
Course code	**UG/BOT/C 07**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:

- Summarize the history and scope of Genetics
- Impart knowledge on the mendelian, post-mendelian genetic concepts and their deviations
- Update the current knowledge of genetics and genomics
- Provide statistical concepts in genetic analysis and plant breeding
- Demonstrate practical skills on genetic analysis

Core Course VII: Genetics

THEORY Lectures: 60

Unit 1: Mendelian genetics and its extension (12 lectures)

Mendelism: History,Pre-Mendelian Concepts of Heredity, Principles of inheritance, Chromosome theory of inheritance; Autosomes and sex chromosomes; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity,Molecular basis of dominance, recessiveness and lethality; Polygenic inheritance

Unit 2: Extrachromosomal Inheritance (6 lectures)

Chloroplast mutation: Variegation in *Mirabilis jalapa*; Mitochondrial mutations in yeast,Maternal effects;

Unit 3: Linkage, crossing over and chromosome mapping (12 lectures)

Linkage and crossing over; Cytogeneticalbasis of crossing over,Holliday model of homologous recombination, Recombination frequency, two factor and three factor crosses;Chromosome mapping using three-point test cross data; Interference and coincidence;Numericals on gene mapping; Sex determination: Sex-linkage

Unit 4: Variation in chromosome number and structure (8 lectures)

Deletion, Duplication, Inversion, Translocation, Position effect,Polytene chromosome; Euploidy and Aneuploidy; Application of aneuploidy

Unit 5: Gene mutations (6 lectures)

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents),Conditional mutation,Detection of mutations; CHmethod;IS elements, Ac-Ds system; Role of Transposons in mutation; DNA repair mechanisms

Unit 6: Fine structure of gene (5 lectures)

Evolution of gene concept; Classical vs molecular concepts of gene; Cis-Trans complementation test (rII Locus) for functional allelism

Unit 7: Population and Evolutionary Genetics (5 lectures)

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Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, patterns of selection(stabilizing, disruptive, directional), mutation, genetic drift,bottlenecking & founder effect, Genetic variation and Speciation, Inbreeding.

Unit 8: Genomics (2 lectures)

Basic idea and its importance; *Arabidopsis*, Rice.

Unit 9: Plant breeding (4 lectures)

Natural and Pureline selection, Hybrid vigour. Male sterility and its use in plant breeding, Role of mutations and polyploidy in crop improvement, Use of apomixis in plant breeding.

PRACTICAL

1. Meiosis from different sources through temporary squash preparations and permanent slides. Identification of stages.

2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.

3. Pedigree analysis for dominant and recessive autosomal and sex linked traits.

4. Incomplete dominance and gene interaction through seed ratios (1:2:1,9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).

5. Blood Typing: ABO groups & Rh factor.

6. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes(ppt).

7. Photographs/Permanent Slides showing meiotic and mitotic abnormalities: Translocation ring, Laggards and Inversion bridge, Multipolarity, Fragmentation, c-mitosis.

8. Study of human genetic traits: Sickle cell anemia, red-green Colour blindness.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Understand the basics of genetic analysis at the gene, genome and population levels.	R, U	PO1, PO2	PSO1, PSO2
CO2	Understand the pattern of inheritance in plants.	U, Ap	PO3	PSO1, PSO2
CO3	Gain knowledge on molecular markers, linkage pattern and mapping techniques.	Ap, An	PO4, PO5	PSO2, PSO4
CO4	Gain knowledge on types of mutation, mutagenic agents and its application in plant breeding.	An, C	PO4, PO5	PSO3, PSO4
CO5	Develop a strong foundation for further molecular studies.	E, C	PO6	PSO5

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.

2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.

4. 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.

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Addition = 35%
Modification = 10%
Total change = 65%.

Semester – IV	
Course name	**Molecular Biology**
Course code	**UGBOTCC08**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives

- Give an idea about structure and function of genetic and hereditary materials.
- Develop understanding of chemical and molecular processes occurring within the cells.
- Give a concept on the central dogma of molecular biology.
- Impart knowledge on regulation of gene expression and gene silencing.

Core Course VIII: Molecular Biology

THEORY

Unit 1:Nucleic acid: Carriers of genetic information (4 lectures)

Historical perspective, DNA as the carrier of genetic information (Griffith's; Hershey &Chase;Avery, McLeod & McCartyandFraenkel-Conrat's experiment).

Unit 2. The Structures of DNA and RNA / Genetic Material (10 lectures)

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes.RNA Structures;Organelle DNA - mitochondria and chloroplast DNA; plasmid DNA.

Unit 2:The replication of DNA (10 lectures)

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, σ mode of replication; replication of linear ds-DNA, replication of the 5′ end of linear chromosome; Enzymes involved in DNA replication.

Unit 3: Central dogma and genetic code (2 lectures)

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features).

Unit 4: Transcription (16 lectures)

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 5: Processing and modification of RNA (8 lectures)

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

Unit 6: Translation (10 lectures)

Ribosome structure and assembly(prokaryote), Charging of tRNA, aminoacyl tRNAsynthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of

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polypeptides;Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

PRACTICAL

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

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Relate the concepts of prokaryotic and eukaryotic gene function.	R, U	PO1, PO2	PSO1, PSO2
CO2	Explain central dogma of molecular biology (replication, transcription, and translation).	U	PO1, PO4	PSO2
CO3	Distinguish between prokaryotic & eukaryotic gene regulation.	An	PO4, PO5	PSO2
CO4	Isolate E. coli & plant DNA and its quantification.	An, E	PO5, PO6	PSO4
CO5	Conversant with Laboratory Techniques viz. centrifugation, gel electrophoresis, spectrophotometry etc.	E, C	PO5, PO6	PSO4, PSO5

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating

Suggested Readings

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

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Addition = 70%
Modification = 05%
Total Change = 75%

Semester – IV	
Course name	**Plant Ecology and Phytogeography**
Course code	**UGBOTCC09**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Create an understanding of various aspects of environment and its components. • Provide an idea about the status and role of biological organisms in the environment. • Provide knowledge on the interactions of biological world with biotic & abiotic factors. • Provide an idea on the phytogeographical distribution of plant communities and their ecological significance.

Core Course IX: Plant Ecology and Phytogeography

THEORY **Lectures: 60**

Unit 1: Introduction (4 lectures)

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

Unit 2: Soil (8 lectures)

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

Unit 3: Water (4 lectures)

Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog and snow); Water in soil; Water table.

Unit 4: Light and temperature (6 lectures)

Variations; Adaptations of plants to their variations.

Unit 5: Biotic interactions (2 lectures)

Trophic organization, basic source of energy, autotrophy, heterotrophy; food chains and webs, ecological pyramids; biomass, standing crop.

Unit 6: Population ecology (4 lectures)

Characteristics and Dynamics of Ecological Speciation.

Unit 7: Plant communities (8 lectures)

Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics; succession – processes, types; climax concepts.

Unit 8: Ecosystems (4 lectures)

Structure; Processes; Trophic organisation; Ecological pyramids.

Unit 9: Functional aspects of ecosystem (8 lectures)

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon and Nitrogen.

Unit 10: Phytogeography (12 lectures)

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Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division.

PRACTICAL

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer /hygrometer
2. Determination of pH of various soil and water samples (pH paper)
3. Analysis for carbonates, chlorides, nitrates from two soil samples by rapid field tests.
4. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
5. Study of morphological adaptations of hydrophytes and xerophytes (four each).
6. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed)
7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
8. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
9. Field visit to familiarize students with ecology of different regions.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Explain various ecosystems & relationships between organisms and environment.	R, U	PO1, PO2	PSO1, PSO2
CO2	Outline various ecosystems and plant distribution.	U, An	PO2, PO3	PSO1, PSO2
CO3	Discuss phytogeography, including major plant communities of the world alongwith climatic conditions of the area.	E, C	PO3	PSO1, PSO2
CO4	Identify phytogeographical regions of India, plant biodiversity and its importance.	Ap, An	PO3, PO4	PSO3
CO5	Analyze plant population and their community.	An, C	PO5	PSO3, PSO5

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating

Suggested Readings

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

2.Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.

3.Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

4.Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

5.Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

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Addition = 30%
Modification = 10%
Total change = 40%.

Semester – IV	
Course name	**Plant Systematics**
Course code	**UGBOTCC10**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Aware the students about diversity, description, identification and nomenclature of plants.
• Make the students acquainted with the different classification systems.
• Increase the understanding of angiosperm phylogeny.

Core Course X: Plant Systematics

THEORY **Lectures: 60**

Unit 1: Significance of Plant systematics (8 lectures)

Introduction to systematics; Plant identification; Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium;E-flora;Documentation: Flora, Monographs, Journals; Keys: Single access and multi access.

Unit 2: Taxonomic hierarchy (6 lectures)

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

Unit 3: Botanical nomenclature (8 lectures)

Principles and rules (ICN); Ranks and names, Typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 4: Systems of classification (8 lectures)

Major contributions of Theophrastus, Linnaeus,Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (up to series).Brief reference of Angiosperm Phylogeny Group (APG III, 2009) classification.

Unit 5: Biometrics, numerical taxonomy and cladistics (8 lectures)

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

Unit 6: Phylogeny of Angiosperms (10 lectures)

Terms and concepts (primitive and advanced,homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).

Unit 7: Systematics (12 lectures)

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Diagnostic characters, systematic position(according to Bentham & Hooker' system) and economically important plants from the following families:

Magnoliaceae,Malvaceae, Leguminosae, Euphorbiaceae, Solanaceae,Verbenaceae,Scrophulariaceae, Acanthaceae, Lamiaceae, Cucurbitaceae, Rubiaceae & Asteraceae.

Alismataceae, Arecaceae, Poaceae, Liliaceae, Zinziberaceae, & Orchidaceae.

PRACTICAL

1. Study of vegetative and floral characters of the following families (Description, V. S. of flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae–*Ranunculus, Delphinium.*

Brassicaceae -*Brassica,Nasturtium.*

Myrtaceae -*Eucalyptus, Callistemon.*

Umbelliferae -*Coriandrum /Anethum / Foeniculum*

Asteraceae -*Sonchus, Vernonia/Ageratum, Eclipta/Tridax*

Solanaceae–*Physalis/ Nicotiana/ Cestrum.*

Lamiaceae – *Anisomeles/ Leucas/ Hyptis.*

Euphorbiaceae -*Euphorbia hirta/ Jatropha.*

Liliaceae -*Lilium/Allium.*

2. Field visit (local and in different phytogeographical regions) – Subject to grant of funds from the authority.

3. Mounting of a number of properly pressed and dried specimens of wild plants with herbarium label (to be submitted along with the record book).

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Know about the diversity and morphology of various angiosperm families.	R, U	PO1, PO2	PSO1, PSO2
CO2	Develop knowledge on plant nomenclature system.	U, Ap	PO1, PO2	PSO2
CO3	Learn and compare various systems of classification.	An	PO4	PSO4
CO4	Acquire knowledge on angiosperm phylogeny and evolution.	An, E	PO4	PSO4
CO5	Upgraded their analytical skills in plant herbarium techniques.	E, C	PO5, PO6	PSO4, PSO6

*R = remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Suggested Readings

1.Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. (3rd ed.)

2.Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.

3.Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd ed.

4.Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.

5.Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

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Semester – V	
Course name	**Reproductive Biology of Angiosperms**
Course code	**UGBOTCC11**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Aware the students about the structure of plant reproductive organs.
• Make the students acquainted with fundamentals aspects of plant growth and development.
• Enhance the understanding of fertilization process and pollen-stigma interaction.
• Provide a foundation on the post-fertilization events in plants.

Core Course XI: Reproductive Biology of Angiosperms

THEORY **Lectures: 60**

Unit 1: **Introduction** (4 lectures)

History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P.Maheshwari, B.M. Johri, W.A. Jensen and J. Heslop-Harrison) and scope.

Unit 2: **Reproductive development** (6 lectures)

Induction of flowering; Flower as a modified determinate shoot; Flower development: genetic and molecular aspects.

Unit 3: **Anther and pollen biology** (10 lectures)

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system, Palynology & its scope (a brief account); Pollen wall proteins; Pollen viability; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 4: **Ovule** (10 lectures)

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase. Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis(details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

Unit 5: **Pollination and fertilization** (6 lectures)

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

Unit 6: **Self incompatibility** (10 lectures)

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

Unit 7: **Embryo, Endosperm and Seed** (10 lectures)

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms.

Units 8: **Polyembryony and apomixis** (4 lectures)

Introduction; Classification; Causes and applications.

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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 ppt 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,unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).

4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus(ppt).

5. Intra-ovarian pollination: Test tube pollination through photographs/ ppt.

6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.

7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs (ppt).

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Understand the molecular and morphological aspects in plant reproductive development.	R, U	PO1, PO2	PSO1, PSO2
CO2	Understand the structure and organization of the male and female reproductive organs.	R, U	PO2	PSO2
CO3	Understand the process of fertilization and pollen-stigma interaction.	R, U	PO4	PSO2, PSO4
CO4	Compare embryo and endosperm development in monocots & dicots.	An, E	PO4, PO5	PSO4
CO5	Address the compatibility & incompatibility issues in angiosperms.	E	PO5	PSO4, PSO5

*R = remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Suggested Readings

1.Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.

2.Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd Delhi.

3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

4. Johri, B.M. 1 (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

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Addition = 40%
Modification = 7%
Total Change = 47%

Semester – V	
Course name	**Plant Physiology**
Course code	**UGBOTCC12**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives
• Gain knowledge on different physiological events in plants.
• Develop understanding of the physiological parameters essential in growth and development.
• Acquire knowledge on the physiology of plants in altered environmental conditions.
• Enable students to design experiments related to basic plant physiology.

Core Course XII: Plant Physiology

THEORY

Unit 1: Plant-water relations (10 lectures)

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap, cohesion-tension theory, cavitation and embolism. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

Unit 2: Mineral nutrition (8 lectures)

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.

Unit 3: Nutrient Uptake (8 lectures)

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, antiport.

Unit 4: Translocation in the phloem (8 lectures)

Experimental evidence in support of phloem as the site of sugar translocation; Composition of phloem sap, Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit 5: Plant growth regulators (14 lectures)

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. Biosynthesis of auxin.

Unit 6: Physiology of flowering (4 lectures)

Photoperiodism, flowering stimulus, florigen concept; Vernalization, effect on flowering.

Unit 7: Seed dormancy and germination (2 lectures)

Seed dormancy(factors) and germination (basic concepts).

Unit 8: Phytochrome, crytochromes and phototropins (6 lectures)

Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

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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 mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

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

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Relate physiological events in plants and their mechanism.	R, U	PO1, PO2	PSO1, PSO2
CO2	Interpret the effect of physiological parameters in plant growth and development.	E	PO2	PSO2, PSO3
CO3	Analyze the physiological adaptations of plants in stress conditions.	An, E	PO2, PO3	PSO3
CO4	Examine physiological mechanism of flowering & requirement of mineral nutrition.	An, E	PO3, PO4	PSO4
CO5	Estimate the effect of various parameters in physiological responses.	E	PO5, PO6	PSO4, PSO5

*R = remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Suggested Readings

- 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. NarosaPublishing House, New Delhi.

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About 15
Addition = 40%
Modification = 15%
Total Change = 55%.

Semester – VI

Course name	**Plant Metabolism**
Course code	**UGBOTCC13**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives

- Impart basic knowledge on physiological and biochemical processes operative in plants.
- Analyze the various pathways involved in respiration and photosynthesis.
- Provide a concept of symbiotic N2 fixation, and their applications in physiological activities.
- Quantify various plant metabolites and their biochemistry and biosynthesis.
- Develop knowledge on how plant system responds metabolically under stress conditions.

Core Course XIII: Plant Metabolism

THEORY

Unit 1: Concept of metabolism (6 lectures)

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

Unit 2: Carbon assimilation (14 lectures)

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments); nature of phycobilins and anthocyanins. Antennamolecules Structure and composition,role in photosynthesis; Reaction centres, photochemical reactions; Photobiology - Absorption and Action spectra, Red drop & Emerson effect,Photosynthetic electron transport, PSI, PSII, Q cycle;Concept of carbon dioxide concentrating mechanism: Carboxysomes in cyanobacteria, Bundle sheath cells in C_4 plants;CO_2 reduction, C_3 cycle, photorespiration,C_4pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit 3: Carbohydrate metabolism (2 lectures)

Synthesis and catabolism of sucrose and starch

Unit 4: Carbon Oxidation (10 lectures)

Glycolysis; amphibolic role, fate of pyruvate, synthesis of acetyl Co-A; regulation of glycolysis,Oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle, TCAcycle;amphibolic role, anapleurotic reactions, regulation of the cycle, mitochondrial electrontransport, oxidative phosphorylation, cyanide-resistant respiration; Thermogenesis; Factors affecting respiration.

Unit 5: ATP-Synthesis (8 lectures)

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (in chloroplast and in mitochondria), ATP synthase, Boyers conformational model, Racker'sexperiment, Jagendorf's experiment; Role of uncouplers.

Unit 6: Lipid metabolism (8 lectures)

Synthesis and breakdown of triglycerides, ß-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination; α oxidation.

Unit 7: Nitrogen metabolism (8 lectures)

Nitrate assimilation, biological nitrogen fixation and process of nodule formation(examples of legumes and non-legumes, heterocyst in cyanobacteria),strategies for O_2 exclusion, Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination; Ammonification; Amino acid

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biosynthesis (by GS-GOGAT, Transamination and direct amination), 7.4 Nitrification, nitrate assimilation and denitrification;

Unit 8: Mechanisms of signal transduction (4 lectures)

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

PRACTICAL

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

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Relate the photosynthetic process of light and dark Reactions.	R, U	PO1, PO2	PSO1, PSO2
CO2	Outline the mechanism of biological N2 fixation.	U	PO3	PSO2, PSO3
CO3	Compare the pigment composition in plants.	U, An	PO4	PSO2
CO4	Understand the mechanism of carbohydrate & lipid metabolism.	U	PO4	PSO4
CO5	Explain the biochemical responses of stress in plants.	Ap, E	PO5, PO6	PSO5

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating

Suggested Readings

- 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.

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Semester – VI	
Course name	**Plant Biotechnology**
Course code	**UGBOTCC14**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:

- Expose students to the techniques in genetic engineering.
- Focus on the concept, scope, and various types plant tissue cultures.
- Provide knowledge on the basic and applied aspects of plant tissue culture.
- Understand the importance of gene technology in plant improvement.

Core Course XIV: Plant Biotechnology

THEORY

Unit 1: Plant Tissue Culture (16 lectures)

Historical perspective;MS media (Murashige and Skoog (1962), Nutrient and plant growth regulatorrequirements; Totipotencyconcept, Organogenesistypes and applications, Embryogenesis (somatic and zygotic)importance, Protoplast isolation, culture andfusionand applications,Callus culture, cell suspension culture and applications; Brief concept andapplications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids; Germplasm conservation, Cryopreservation).

Unit 2: Recombinant DNA technology (12 lectures)

Restriction Endonucleases (History, Types I-IV, biological role and application); Cloning vectors: Prokaryotic (pUC-18, pBR322,Ti plasmid).

Unit 3:Gene cloning (10 lectures)

Concept of recombinant DNA, Bacterial Transformation and selection of recombinant clones,Cell freePCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, Screening of DNA libraries to obtain gene of interest by genetic selection.

Unit 4: Methods of gene transfer (8 lectures)

Concept and importance of gene transfer. *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes.

Unit 5: Applications of Biotechnology (14 lectures)

Concept of Genetically modified crops. GM Crop and Hybrids from crop breeding.Pest resistance (Bt-cotton); Herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Golden rice).

PRACTICAL

1. (a) Sterilization techniques (Dry method, wet method and Filtration method)

(b) Preparation of MS medium.

(c) Demonstration of *in vitro* sterilization disinfection and inoculation methods using leaf and nodal explants.

(d) Demonstration of callus induction from leaf and internode explants.

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2. Demonstration of anther, embryo culture and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds.

3. Demonstration of Isolation of protoplasts.

4. Demonstration of methods of gene transfer: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.

5. Isolation of plasmid DNA.

6. Restriction digestion and gel electrophoresis of plasmid DNA.

7. Demonstration of PCR mediated gene cloning.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Recall the basic concepts of biotechnology and explain its fundamental applications.	R, U	PO1, PO2	PSO1, PSO2
CO2	Become familiar with the tools and techniques of genetic engineering.	U, Ap	PO2	PSO1, PSO2
CO3	Acquire knowledge on the application of gene cloning in agriculture.	Ap	PO2, PO3, PO4	PSO3
CO4	Translate the concepts in future studies and debate on issues related to GMOs.	An, E	PO3, PO5	PSO3, PSO4
CO5	Design plant tissue culture and RDT experiments to address a research problem.	E, C	PO5, PO6	PSO4, PSO5

*R = remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Suggested Readings

1.Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

2.Glick, B.R., Pasternak, J.J. (2022). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

3.Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.

4.Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley & Sons, U.K. 5th ed.

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

6.Stewart, C.N. Jr. (2016) Plant biotechnology and Genetics-Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

7.Rieroch A, Chopra S. & Fleischer SJ. (ed) Plant Biotechnology- Experience and Future Prospects.

8.Jha T.B &Ghosh B. (2016) Plant Tissue Culture-Basic and Applied. (2nd Ed) Platinum Publication.

9.Bhojwani S.S. and Dantul P.K (2013) Plant Tissue Culture: An Introductory Text. Springer.

10. Bhatia S.,Sharma K &Dahiya R. (2015) Modern Applications Of Plant Biotechnology In Phermaceutical Sciences. Elsevier Inc.

11. H. S. Chawla (2000) Introduction to Plant Biotechnology. Science Publishers.

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DISCIPLINE SPECIFIC

ELECTIVE

Newly Introduced.
Total change = 100%

Semester – V	
Course name	**Industrial and Environmental Microbiology**
Course code	**UGBOTDSE01**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:

- Develop knowledge on the microbes involved in fermentation & basics of fermentation technology.
- Provide an idea about design of fermenter, media composition and process of fermentation.
- Provide knowledge on the use of microbes in environmental cleanup.
- Provide an idea about the use of microbes for production of important industrial products.

DSE 1: Industrial and Environmental Microbiology

THEORY **Lectures: 60**

Unit 1: Scope of microbes in industry and environment **(6 lectures)**

Role of microbes in various industry (Agriculture, Pharmaceutical, Textile etc.) Role of microbes in environmental managements (sewage treatment, environmental indicators, bioremediation of contaminated soils etc.).

Unit 2: Bioreactors/Fermenters and fermentation processes **(12 lectures)**

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratories, pilot scale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

Unit 3: Microbial production of industrial products **(12 lectures)**

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin)

Unit 4: Microbial enzymes of industrial interest and enzyme immobilization **(8 lectures)**

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 5: Microbes and quality of environment. **(6 lectures)**

Distribution of microbes in air; Isolation of microorganisms from soil, air and water

Unit 6: Microbial flora of water. **(8 lectures)**

Water pollution, role of microbes in sewage and domestic waste water treatment systems.

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Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators ofwater quality, check coliform and fecal coliform in water samples.

Unit 7: Microbes in agriculture and remediation of contaminated soils. **(8 lectures)**

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.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Outline the basic aspects of microbial science in industrial application.	R, U	PO1	PSO1, PSO2
CO2	Explain various aspects of fermentation technology.	U, Ap	PO1, PO2	PSO1, PSO2
CO3	Develop knowledge on the current updates in agriculture & environmental microbiology.	Ap, An	PO3	PSO3
CO4	Develop ideas on the routine and specialized microbiological laboratory skills.	Ap, An	PO3, PO4	PSO4
CO5	Design and formulate research activities in applied microbiology.	E, C	PO5, PO6	PSO5

*R= remembering, U = understanding, Ap = applying, An = analyzing, E = evaluating, and C = creating

Suggested Readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application basedapproach. Tata McGraw Hill Education Pvt. Ltd., Delhi.

2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

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Addition = 65%.

Total Change = 65%.

Semester – V	
Course name	**Plant Breeding**
Course code	**UGBOTDSE02**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• To develop knowledge on the components to formulate a plant breeding programme.
• Describe various methods which are used in plant breeding.
• Provide an idea about the biotic and abiotic stress tolerant crop varieties.

Plant Breeding

THEORY **Lectures: 60**

Unit 1: Plant Breeding **(10 lectures)**

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit 2: Methods of crop improvement **(20 lectures)**

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self- pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 3: Quantitative inheritance **(10 lectures)**

Concept, mechanism, examples of inheritance of Kernel colour in wheat. Monogenic vs polygenic Inheritance.

Unit 4: Inbreeding depression and heterosis **(10 lectures)**

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 5: Crop improvement and breeding **(10 lectures)**

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

PRACTICAL

1. Visit to an agricultural farm
2. Emasculation technique
3. Nursery technique

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Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Gather knowledge to design, execute, analyze results of genetic experiments in plant breeding systems.	R, U	PO1, PO2	PSO1, PSO2
CO2	Demonstrate practical emasculation and pollination methods in crop plants.	U, Ap	PO4	PSO2
CO3	Understand the patterns of inheritance in plants.	Ap, An	PO3, PO4	PSO4
CO4	Examine the methods of crop improvement.	An, E	PO5	PSO4
CO5	Formulate and justify the application of plant breeding methods to achieve a specific objective.	E, C	PO5, PO6	PSO5

*R – remembering, U – understanding, Ap – applying, An – analyzing, E – evaluating, and C – creating

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7thedition.

2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH.2nd edition.

3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

4. Rajpal V. R., Rama Rao S. & Raina S. N.(editors). Molecular Breeding for Sustainable Crop Improvement. Vol I & II. Springer.

5.Mahgoub S. E. O. (2016) Genetically Modified Foods- Basics, Applications and Controversy. CRC Press.

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Addition = 30%.

Total Change = 30%.

Semester – VI	
Course name	**Biostatistics**
Course code	**UGBOTDSE03**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:

- Recognize the concept of statistics and its relation with biology.
- Conceptualize, Summarize, organize and display of quantitative data.
- Provide knowledge on different types of data and sampling techniques.
- Calculate and interpret results of biostatistical analyses.

Biostatistics

THEORY **Lectures: 60**

Unit 1: Biostatistics **(12 lectures)**

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

Unit 2: Collection of data primary and secondary **(12 lectures)**

Types and methods of data collection procedures - merits and demerits. Classification -tabulation and presentation of data - sampling methods.

Unit 3: Measures of central tendency **(14 lectures)**

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

Unit 4: Correlation **(12 lectures)**

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

Unit 5: Statistical inference **(10 lectures)**

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

PRACTICAL

1) Calculation of mean, standard deviation and standard error

2) Calculation of correlation coefficient values and finding out the probability

3) Calculation of 'F' value and finding out the probability value for the F value.

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Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Organize biological data and calculate descriptive statistics from these data.	R, U, Ap	PO1, PO2	PSO1
CO2	Compute and interpret biological variability.	Ap, An	PO2, PO3	PSO2
CO3	Compare different biological population using statistical algorithms.	Ap, An	PO4	PSO3, PSO4
CO4	Evaluate tests to perform hypothesis testing and experimental design for biological experiments.	An, E	PO5, PO6	PSO4, PSO5
CO5	Discuss the use of statistical software and packages in biostatistics.	E, C	PO6	PSO4

*R – remembering, U – understanding, Ap – applying, An – analyzing, E – evaluating, and C – creating

Suggested Readings

1. Biostatistic, Danniel, W.W., 1987 New York, John Wiley Sons.

2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S. and Richards, J. Christian Medical College, Vellore

3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.

4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.

5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.

6. Statistics for Biologists, Campbell, R.C., 1998 Cambridge University Press.

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Newly Introduced
Total change = 100%

Semester – VI	
Course name	**Applied Phycology**
Course code	**UGBOTDSE04**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:

- Recognize the economic and applied aspects of algae.
- Summarize the basic concepts in algal culture.
- Provide knowledge on the industrial products obtained from algae.

Applied Phycology

THEORY **Lectures 60**

Unit:1 **5 lectures**

Basic techniques for culturing of algae (media composition, media preparation, sterilization and inoculation)

Unit:2 **5 lectures**

Mass culture techniques in algae (continuous culture, outdoor culture, photobioreactors)

Unit:3 **8 lectures**

Nitrogen fixation by algae (Symbiotic and non-symbiotic; Heterocystous and non-heterocystous)

Unit:4 **10 lectures**

Algal secondary metabolites: Basic concepts, halogenated compounds, tetraterpenes, alkaloids, allelopathic compounds; Phermaceuticals; Cosmetic products

Unit:5 **5 lectures**

Carotenoid production (α – and β – carotenes, xanthophyll, astaxanthin, violaxanthin, & zeaxanthin), techniques of increase of production through stress (salinity and light & its utilization (*Haematococcus*, *Dunaliella*, & *Chlorella*)

Unit:6 **5 lectures**

Algae as alternate food source (kombu, nori, askanori, blanchmanges)

Unit:7 **8 lectures**

Algae as source of phycocolloids (agar agar, alginates, carrageenan) and their utilization

Unit:8 **5 lectures**

Algae and bio-diesel production (*Isochrysis*, *Botrydium* & others)

Unit:9 **5 lectures**

Diatomaceous earth and its uses (as polishing agent, in filtration bed, in lining of furnaces & in production of insulating panels)

Unit:10 **4 lectures**

Algal bloom: Its harmful effects and its control

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PRACTICAL

1. Media preparation and batch culture
2. Culture techniques for *in vitro* production of SCP (*Spirulina*, *Scenedesmus* etc.)
3. Assessment of growth in algal culture (Chlorophyll estimation)
4. Assay of carbohydrate production
5. Detection of antimicrobial compound in algae
6. Identification of important N_2 fixing cyanobacteria

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Outline the various aspects of applied phycology.	R, U	PO1, PO2	PSO1, PSO2
CO2	Develop knowledge on harmful algae and their remedy.	U, Ap	PO3	PSO3
CO3	Identify algal sources of food, phycocolloids, fuel.	Ap, An	PO4, PO5	PSO3, PSO4
CO4	Plan and formulate culture of economically important species.	An, E	PO5, PO6	PSO4
CO5	Formulate the application of algal species to solve a human demand.	E, C	PO6	PSO4, PSO5

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating

Suggested Readings

1. R. E. Lee (2008) Phycology. 4th edition Cambridge University Press
2. James E. Graham, Lee W. Wilcox, Linda E. Graham (2008) Algae 2nd edition. Benjamin Cummings
3. Laura Barsanti et al. Algae: Anatomy, Biochemistry and Biotechnology. 2nd edition. CRC Press

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Newly Introduced
Total Change = 100%

Semester – VI	
Course name	**Research Methodology**
Course code	**UGBOTDSE05**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Understand the basic concepts of biological research.
• Select and define appropriate research problem and parameters.
• Organize and conduct research in a more appropriate manner.
• Provide knowledge on research proposal and report writing.

Research Methodology

Theory **Lectures: 60**

Unit 1: Basic concepts of research **(10 lectures)**

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit 2: General laboratory practices **(12 lectures)**

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions, molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

Unit 3: Data collection and documentation of observations **(6 lectures)**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography.

Unit 4: Overview of Biological Problems **(6 lectures)**

Key biology research areas. Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics- Transcriptional regulatory network.

Unit 5: Methods to study plant cell/tissue structure **(6 lectures)**

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

Unit 6: Plant microtechniques **(12 lectures)**

Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

Unit 7: The art of scientific writing and its presentation **(8 lectures)**

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

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Practical

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Discuss and demonstrate methodologies and techniques used in biological research.	R, U	PO1, PO2	PSO1
CO2	Explain and execute basic computer skills necessary for the conduct of research.	Ap, An	PO1, PO2	PSO1, PSO2
CO3	Assess the basic function and working of analytical instruments used in research.	An, E	PO4	PSO2
CO4	Identify the overall process of designing a research study from its inception to its report.	E, C	PO4, PO5	PSO4
CO5	Explain the rationale for research ethics and demonstrate its contribution in research career.	E, C	PO5, PO6	PSO4, PSO5

*R = remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

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GENERIC

ELECTIVE COURSE

(GE)

Addition = 40%
Modification = 5%
Total change = 45%.

Semester – I	
Course name	**Cryptogamic Botany**
Course code	**UGBOTGE01**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Understand the basic features of cryptogams and their diversity.
• Explain the structure, function and classification of lower plant groups.
• Elaborate the ecological and economic importance of the cryptogams.

Cryptogamic Botany

THEORY **Lectures: 60**

Unit 1: Bacteria and Viruses **(12 lectures)**

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae **(14 lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Fucus*, *Polysiphonia*. Economic importance of algae.

Unit 3: Fungi **(14 lectures)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota), *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations- Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 4: Introduction to Archegoniate **(4 lectures)**

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 5: Bryophyta **(8 lectures)**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecological and economic importance of Bryophytes with special mention of *Sphagnum*.

Unit 6: Pteridophyta **(8 lectures)**

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included) Heterospory and seed habit, Ecological and economical importance.

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PRACTICAL **Lectures: 30**

1. Types of Bacteria from temporary/permanent slides/photographs; EM of bacterium; Binary fission; Conjugation; Structure of root nodule.

2. Gram staining.

3. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (EM), *Oedogonium*, *Fucus* Polysiphonia* through temporary preparations and permanent slides. (**Fucus* – Specimen)

4. *Rhizopus* and *Penicillium*: Asexual stage (temporary mounts) and sexual structures (permanent slides).

5. *Alternaria*: Specimens/photographs and tease mounts.

6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.

7. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.

8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose).

9. Mycorrhiza: ecto-mycorrhiza and end-mycorrhiza (Photographs).

10. *Marchantia*- morphology, W.M. of rhizoids and scales, V.S. of gemma cup, W.M. of gemmae, V.S. of antheridiophore, archegoniophore, L.S. of sporophyte (all permanent slides).

11. *Funaria*- morphology, W.M. of leaf, rhizoids, operculum, peristome, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. of capsule and W.M. of protonema.

12. *Selaginella*- morphology, W.M. of leaf with ligule, T.S. of stem, W.M. of strobilus, W.M. of microsporophyll and megasporophyll (temporary slides), L.S. of strobilus (permanent slide).

13. *Equisetum*- morphology, T.S. of internode, L.S. of strobilus, T.S. of strobilus, W.M. of sporangiophore, W.M. of spores (wet and dry) (temporary slides).

14. *Pteris*- morphology, T.S. of rachis, V.S. of sporophyll, W.M. of sporangium and spores (temporary slides), T.S. of rhizome, W.M. of prothallus with sex organs and young sporophyte (permanent slide).

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Understand the diversity of lower plant groups.	U, R	PO1, PO2	PSO1
CO2	Know the systematic, morphology and structure, of Bacteria, Viruses and Algae.	U, R	PO2, PO3	PSO1, PSO2
CO3	Understand the life cycle patterns of Cryptogams.	U, R	PO4	PSO3
CO4	Understand the useful and harmful features of Bacteria, Viruses and Algae.	Ap, An, E	PO5	PSO4, PSO5
CO5	Understand the economic importance of Bryophytes and Pteridophytes.	An, E	PO5, PO6	PSO4, PSO5

*R – remembering, U – understanding, Ap – applying, An – analysing, E – evaluating, and C – creating

Suggested Reading

1. Kumar, H.D. Introductory Phycology, Affiliated east west press Pvt. Ltd. New Delhi 2nd edition.

2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd.

4. Alexopoulos, C.J, Mims, C.W, Blackwell, M. (1996) Introductory Mycology, 4th ed John Wiley & Sons

5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.

6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

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Addition = 20%
Modification = 5%
Total Change = 25%

Semester – II	
Course name	**Biology of Vascular Plants**
Course code	**UGBOTGE02**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Study the diversity of Gymnosperms and its role in evolution.
• Study the diversity of Angiosperms.
• Complement the students with the basic knowledge of plant taxonomy.

Biology of Vascular Plants

THEORY **Lectures: 60**

Unit 1: Gymnosperms **(15 lectures)**

General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

Unit 2: Taxonomy and Hierarchy **(14 lectures)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access. Ranks, categories and taxonomic groups.

Unit 3: Botanical nomenclature **(12 lectures)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 4: Classification **(4 lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (up to series).

Unit 5: Systematics **(15 lectures)**

Diagnostic characters of the following families: Malvaceae, Solanaceae, Leguminosae, Cucurbitaceae and Poaceae. Economically important angiospermic plants: Wheat, Gram, Black pepper, Tea, ground nut, Cotton and Cinchona.

PRACTICAL **Lectures: 30**

1. *Cycas*- morphology (coralloid roots, bulbil, leaf), T.S. coralloid root, T.S. rachis, V.S. leaflet, V.S. of microsporophyll, W.M. of spores (temporary slides), L.S. of ovule, T.S. of root (permanent slide).

2. *Pinus*- morphology (long and dwarf shoots, male and female cones), W.M. of dwarf shoot, T.S. of needle, T.S. of stem, L.S. of male cone, W.M. of microsporophyll, W.M. of microspores (temporary slides), L.S. of female cone, T.L.S. & R.L.S. of stem (Permanent slides).

4. Study of vegetative and floral characters of the following: (Description, V. S. of flower, T.S./ L.S. of ovary, floral diagram, floral formula and systematic position according to Bentham & Hooker).

Hibiscus vitifolia/ Abutilon indicum, Solanum sp./ Cestrum sp; Crotalaria sp./ Cassia sp.; Coccinia grandis.

5. Mounting of dried and pressed specimens of wild angiosperms with herbarium label (To be submitted along with the record book).

6. Study of economically important plants: Wheat, Gram, Black pepper, Clove, Cotton and Ground nut.

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Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Outline ecological and evolutionary importance of the angiosperm and gymnosperm.	R, U	PO1, PO2	PSO1, PSO2
CO2	Explain the economic importance of the angiosperm and gymnosperm.	U, Ap	PO2, PO3	PSO2, PSO3
CO3	Analyze and evaluate a comparative account of angiospermic families.	Ap, An	PO4	PSO3
CO4	Discuss the systematic position and classification of angiosperm and gymnosperm.	E, C	PO4	PSO3
CO5	Analyze and examine various angiosperm families and their economically important members.	C	PO5, PO6	PSO4, PSO5

*R = remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Suggested Reading

1. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

2. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

3. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.

4. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

5. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.

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Addition = 45%
Modification = 5%
Total change = 50%

Semester – III	
Course name	**Plant Ecology, Anatomy and Embryology**
Course code	**UGBOTGE03**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Study plant communities and ecological adaptation in plants.
• Acquaint students with basic concepts of plant anatomy.
• Study various plant tissue system.
• Study the physiology of plant reproduction.

Plant Ecology, Anatomy and Embryology

THEORY **Lectures: 60**

Unit 1: Ecological factors **(10 lectures)**

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.

Unit 2: Plant communities **(6 lectures)**

Characters; Ecotone and edge effect; Succession; Processes and types

Unit 3: Ecosystem **(6 lectures)**

Structure; energy flow trophic organization; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous.

Unit 4: Phytogeography **(4 lectures)**

Main phytogeographical zones of India, endemism.

Unit 5: Meristematic and permanent tissues **(6 lectures)**

Root and shoot apical meristems; Simple and complex tissues

Unit 6: Secondary Growth **(8 lectures)**

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)

Unit 7: Adaptive and protective systems **(8 lectures)**

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 8: Pollination and fertilization **(6 lectures)**

Pollination mechanisms and adaptations; Double fertilization.

Unit 9: Embryo and endosperm **(6 lectures)**

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm Relationship

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PRACTICAL **Lectures: 30**

1. (a) Study of morphological adaptations of hydrophytes and xerophytes (Two each).

(b) Study of biotic interactions of Stem parasite (*Cuscuta*) and Epiphyte (*Vanda*).

2. Tissues (Parenchyma, collenchyma and sclerenchyma); Macerated xylary elements; Phloem (permanent slides / photographs).

3. Stem: Secondary growth in *Helianthus* (only Permanent slides).

4. Root: Secondary growth in *Tinospora* (only Permanent slides); Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).

5. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).

(Permanent slides/photographs).

6. Ultrastructure of mature egg apparatus cells through electron micrographs.

7. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, hygrometer, rain gauge and lux meter.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Illustrate the basic concept of ecology and its biotic and abiotic components.	R, U	PO1, PO2	PSO1, PSO2
CO2	Explain and interpret the relationship between organisms and its ecosystem.	U, Ap	PO3	PSO3
CO3	Distinguish the normal and anomalous secondary growth in plants.	Ap, An	PO4	PSO2
CO4	Analyze biodiversity at various levels and prioritize its conservation.	An, E	PO5	PSO4
CO5	Discuss plant reproduction and post reproductive events.	E, C	PO5, PO6	PSO5

*R – remembering, U – understanding, Ap – applying, An – analyzing, E – evaluating, and C – creating

Suggested Reading

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.

2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

3. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

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Addition = 15%. 15%
Modification = 5%
Total change = 20%.

Semester – IV	
Course name	**Plant Physiology and Biotechnology**
Course code	**UGBOTGE04**
Number of lectures	**90 (Th: 60 + Pr: 30)**
Credits	**4 (Theory) + 2 (Practical) = 6**
Marks	**100**

Course Objectives: This course aims to

Course Objectives:
• Know the importance and scope of plant physiology.
• Study plant and plant cell in relation to water.
• Understand the growth of plants at various level.
• Know the importance and procedures of tissue culture.

Plant Physiology and Biotechnology

THEORY **Lectures: 60**

Unit 1: Plant tissue culture **(10 lectures)**

Concept of totipotency; Tissue and organ culture; Micropropagation; Haploid culture; Ovary and endosperm culture; Applications of these techniques.

Unit 2: Plant-water relations **(6 lectures)**

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 3: Translocation in phloem. **(6 lectures)**

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Photosynthesis **(10 lectures)**

Photosynthetic Pigments (Chl a, b, xanthophylls and carotenoids); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3 cycle; Significance of C_4 and CAM pathways; Photorespiration and its significance;

Unit 5: Respiration **(8 lectures)**

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation.

Unit 6: Plant growth regulators **(8 lectures)**

Physiological roles of Auxins, Gibberellins, Cytokinins, ABA, Ethylene.

Unit 7: Plant response to light and temperature **(12 lectures)**

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

PRACTICAL **Lectures: 30**

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. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
5. Comparison of the rate of respiration in any two parts of a plant.

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6. Familiarization with basic equipment's in tissue culture.

7. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; Micropropagation.

Course Outcome: After completion of this course the student will be able to

CO No.	Course Outcomes	Cognitive Level	POs Addressed	PSOs Addressed
CO1	Explain and summarize the process of photosynthesis with emphasis on light and dark reactions, C3 and C4 pathways.	R, U	PO1, PO2	PSO1, PSO2
CO2	Outline respiration with emphasis on energy yield.	R, U	PO2	PSO3
CO3	Analyze the various physiological activities within plant body.	Ap, An	PO3	PSO4
CO4	Evaluate various types of tissue culture methods.	An, E	PO4, PO5	PSO4, PSO5
CO5	Discuss the importance and application of tissue culture.	An, E	PO5, PO6	PSO5

*R = remembering, U = understanding, Ap = applying, An = analyzing, E = evaluating, and C = creating

Suggested Readings

1. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

3. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

4. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

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ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

Semester – I	
Course name	**English Communication**
Course code	**UGAECC01**
Number of lectures	**60**
Credits	**4**
Marks	**50**

English Communication

Unit I: Introduction to Communication

- Process of Communication
- Levels of Communication
- Flow of Communication
- Verbal and Non-Verbal Communication
- Barriers to Communication

Unit II: Listening and Speaking Skills

- Listening and its types.
- Barriers to effective listening.
- Trials of a good listener.
- Introduction to English Phonetic Symbols: Consonants and Vowels with illustrations in use.
- Dialogue
- Group Discussion
- Presentation
- Interview Technique.

Unit III: Reading and Writing Skills

- Techniques of Reading
- Types of Reading
- Reading Comprehension (unseen passage)
- Paragraph Writing
- Letter Writing
- Email Writing
- Report Writing
- Proposal writing
- Book Review
- Poster Making

Prescribed Books:

1. Vibrant English (New Delhi: Orient Black Swan)
2. Speak Well (New Delhi: Orient Black Swan) a compulsory supplementary Work Book for exercises on Interactions, dialogue, presentation skills, Group discussions, debates and Interviews.

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Recommended Readings for advanced learning:

1. Advanced Skills in English. eds E Suresh Kumar et al.
2. Practicing Writing Skills, Work Book
3. Enhancing English and Employability Skills
4. Business Communication,
5. English for Fluency
6. English Language Practice
7. Basics of Academic English- 1 and 2
8. Practicing English- all these are Orient Black Swan publications

Course Outcome: At the end of the program, the students will be able to:

CO	Course Outcome	Cognitive level	POs Adressed	PSOs Adressed
CO1	Engage in self-directed English language learning.	R,	PO, PO2, PO3	PSO1
CO2	Be responsible and ethical English users.	R, U	PO1, PO2, PO3	PSO1
CO3	Enhance their English language proficiency in the aspects of reading, writing, listening and speaking.	R, U	PO1, PO2, PO3	PSO1
CO4	Develop academic literacy required for undergraduate learning, further studies and research.	Ap	PO3, PO5	PSO2
CO5	Apply the requisite communicative skills and strategies to future careers.	Ap,	PO3, PO5	PSO2
CO6	Gain an insight into cultural literacy and cross-cultural awareness.	Ap	PO3, PO5	PSO2

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Total Charge = 100/-

Semester – II	
Course name	**Environmental Science (ENVS)**
Course code	**UGAECC02**
Number of lectures	**60**
Credits	**4**
Marks	**50**

Course Objectives: This course aims to

Course Objectives:

- Remember and understand the concept, components and function of natural resources and ecosystems.
- Understand and evaluate the Cause, effects and control measures of various environmental pollutants.
- Understand the basic idea about the disasters and its management.
- Understand and apply the knowledge about the social, environmental issues and environmental legislation.

Environmental Science

1. **Definition**, scope and importance. Need for public awareness. (2 lectures)
2. **Natural Resources: Renewable and non-renewable**: Forest, Water, Mineral, Food, Energy & Land resources – Use and associated problems. (8 lectures)
3. **Ecosystems:** Concept, Structure and function, Energy flow, Ecological succession, Food chains, food webs and ecological pyramids. Types – Forest, Grassland, Desert & Aquatic (ponds, streams, lakes, rivers, oceans, estuaries) ecosystems. (12 lectures)
4. **Environmental Pollution:** Definition, Cause, effects and control measures of - Air, Water, Soil, Noise pollution and Nuclear hazards. Solid waste Management. Role of an individual in prevention of pollution. (10 lectures)
5. **Disasters and management**: Floods, Earthquake, Cyclone and Landslides. (4 lectures)
6. **Social Issues and the Environment:** Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Urban problems related to energy. (10 lectures)
7. **Environmental legislation:** Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. (8 lectures)
8. **Human Population and the Environment:** Population growth, variation among nations; Population explosion – Family Welfare Programme; Environment and human health (including HIV/AIDS); Human Rights; Role of Information Technology in Environment and human health. (6 lectures)

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Course Outcomes: After completion of this course the student will be able to

CO No.	Course Outcomes:	Cognitive Level	PO Addressed	PSOs Addressed
CO 1:	Define and demonstrate the concept, components and function of natural resources and ecosystems.	R, U	PO1	PSO1, PSO2
CO 2:	Define, illustrate and analyze cause, effects and control measures of various environmental pollutants.	R, U, An	PO 3	PSO2, PSO3
CO 3:	Demonstrate the basic idea about the disasters and its management.	U	PO 3	PSO3
CO 4:	Illustrate and apply the knowledge about the social, environmental issues and environmental legislation.	U, Ap	PO 4	PSO4
CO 5:	Define, demonstrate and evaluate the impact of human population on the Environment	R, U, E	PO 6	PSO5

*R = remembering, U = understanding, Ap = applying, An = analyzing, E = evaluating, and C = creating

References:

1. Agarwal KC, 2001. Environmental Biology, Nidi Publishers Ltd. Bikaner.
1. Bharucha Erach, 2003. The Biodiversity of India, Mapin Publishing Pvt. Ltd, Ahmedabad – 380013, India. Email: mapin@icenet.net
2. Brunner RC, 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480pgs.
3. Clark RS, Marine Pollution, Clanderson Press, Oxofrd (TB).
4. Cunningham WP, Cooper TH, Gorhani E & Hepworth MT, 2001. Environmental Encyclopaedia, Jaico Publishing House, Mumbai, 1196pgs.
5. De AK, Environmental Chemistry, Wiley Eastern Ltd.
6. Down to Earth, Center for Science and Environment (R)
7. Gleick HP, 1993. Water in Crisis, Pacific Institute for Studies in Development, Environment and Security. Stockholm Environmental Institute, Oxford University Press, 473pgs.
8. Hawkins RE, Encyclopaedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
9. Heywood V H and Watson R T, 1995. Global Biodiversity Assessment. Cambridge University Press 1140pgs.
10. Jadhav H and Bhosale VM, 1995. Environmental Protection and Laws. Himalaya Publishing House, Delhi 284pgs.
11. Mckinney ML and Schoch RM, 1996. Environmental Science Systems and Solutions. Web enhanced edition, 639pgs.
12. Mhaskar AK, Matter Hazardous, Techno-Science Publications (TB)
13. Miller TG, Jr. Environmental Science, Wadsworth Publishing CO. (TB)
14. Odum EP, 1971. Fundamentals of Ecology. WB Saunders Co. USA, 574pgs.
15. Rao MN and Datta AK, 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd. 345pgs.

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SKILL ENHANCEMENT COURSE (SEC)

Semester – III	
Course name	**Value Education and Indian Culture**
Course code	**UGBOTSEC01**
Number of lectures	**60**
Credits	**4**
Marks	**50**

Course Objectives: This course aims to

Course Objectives:

- Attain awareness about daily routine, self-evaluation & integral personality development.
- Understand the educational needs, the power of thoughts and the science of peace.
- Understand the relation: Values and enlightened citizenship.
- Demonstrate the importance of four yogas.
- Acquire idea about modern India: her hopes, challenges and Swami Vivekananda.

Value Education and Indian Culture

Unit1: Daily Routine: **6 class**

- A suggested daily routine
- The daily routine & the concept of Biological clock: key to a healthy and productive life
- Necessity for an all-round daily routine
- Combining Rest and Activity, Hardships and Joy in a daily routine
- The scope of developing the power of concentration and detachment through a daily routine
- Daily Routine disciplines the system but confers conviction on oneself

Unit2: Self Evaluation & Integral Personality Development: **8 classes**

- Why is Self-Evaluation important? Because if you win yourself, you win the world
- Quantitative Self Evaluation for a qualitative change: A method
- Traits to track Personality Development: Academic Excellence, Social Compatibility, Participation in Group events, Sense of Responsibility, Role as a Consumer, Scientific Temperament, Aesthetic taste and creativity, Leisure time Activities, Concern for others, Spiritual values.
- Close and Constant Self Evaluation: a stitch in time saves nine
- The world *is* as we *are* : A minor inner change may nullify a major outer perturbation

Unit3: Our Educational Needs **8 classes**

- The need of a correct blend of inner and outer well-being in education
- Man-making, Character building education : growing from within , a surer foundation of progress
- The outer crust and the inner core of our personality: "What you are shouts so loudly in my ears that I cannot hear what you say."
- A 5-point training in Discipline, Cleanliness, Behaviour, Manners and Ambition
- Sharpening the sword of will: controlling its expression, a basic educational need
- How to study effectively?

Unit4: The Power of thoughts and the Science of Peace **5 class**

- Shanti Mantras: Peace can be radiated from and reflected back upon ourselves
- You can create an ambience and others can enjoy it, can be benefitted by it
- How to create a positive, peaceful and inspiring ambience?- the aggressive exertion and the unquestioning sacrifice involved in it

Unit5: Subhashita: The Well said **4 class**

- Bringing home high thoughts in nuggets of wisdom
- Pearls of Wisdom and flames of fire: simple parables and anecdotes from the great ones.

Unit6: Values and Enlightened Citizenship **4 classes**

- Intrinsic and Instrumental Values
- What makes a man great? A powerful will to do good born out of self-control and self-sacrifice

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- Learning the art of inter-personal relations: Not I but You
- The combination of the Head, Heart and Hand: a valuable value for Enlightened Citizenship

Unit7: Indian Practice and Culture **5 classes**

- The idea of sacredness & its necessity
- Every aspect of life is sacred in India
- Renunciation and service the twin ideals for India
- My freedom from Nature helps me to serve nature and the world better
- I never say I am the body, I always say this body is mine : I as a master of the body-mind complex
- Weakness is death: in search of real strength of self-knowledge, reliance on God and unselfish service
- Meditation, Concentration and the silent Indian path for becoming a dynamo of power
- The Indian concept of Unity in diversity: Harmony of Religions

Unit8: Four Yogas **6 classes**

- The Real and Apparent Man, the science of knowing myself: Jnana Yoga
- Taming the mighty current of emotions and giving them their right food: Bhakti Yoga
- The Science of working wisely: Karma Yoga
- The Process of making my mind mine: Raja Yoga
- Selected portions from Swami Vivekananda's Karma Yoga
- Harmony of 4 Yogas: a needed balance for the modern man

Unit9: Modern India: her hopes, challenges and Swami Vivekananda **6 classes**

- Swami Vivekananda's method of combining the best of the East & the West: where Indian values and Western workmanship join hands
- Invigorating rationality in the field of the Indian search for the supreme joy : erasing the misconception of dogmatism
- Rousing a sense of pride in the age-long Indian discoveries in the field of inner truths as opposed to an inferiority complex posed by Western material supremacy.
- Do you feel Service, Swami Vivekananda's acid test for modern science and traditional spirituality.

Unit10: Students' Presentations/Project: (may be in groups) **10 classes**

Project on Service, Teaching and Cleanliness

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	Cognitive Level	POs Addressed	PSOs Addressed
CO 1:	Define, demonstrate and apply the daily routine, self-evaluation & Integral Personality Development	R, U, Ap	PO1	PSO1, PSO2
CO 2:	Demonstrate, and apply the Power of thoughts & the Science of Peace	U, Ap	PO3	PSO2
CO 3:	Demonstrate the relation between Values and enlightened citizenship	U	PO3	PSO3
CO 4:	Discuss awareness about Indian Practice and Culture	C	PO4	PSO3
CO 5:	Demonstrate and practice the Four Yogas	U, Ap	PO6	PSO4
CO 6:	Explain and analyse the idea about Modern India: her hopes, challenges and Swami Vivekananda	U, An	PO4, PO6	PSO4

*R – remembering, U – understanding, Ap – applying, An – analyzing, E – evaluating, and C – creating

Books for Reference:

1) Jiivan Sopan, Published by Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata
2) Swami Vivekananda : His Call to the Nation, Advaita Ashrama
3) Thoughts of Power: Swami Vivekananda, Advaita Ashrama
4) Swami Vivekananda, The Friend of all, Ramakrishna Mission Institute of Culture,Golpark, Kolkata
5) Gems, Ramakrishna Mission Institute of Culture, Golpark, Kolkata

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