



UNIVERSITY OF CALCUTTA

Notification No. CSR/63/2025

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 04.09.2025 approved the revised Course Structure for 4-Year Honours and Honours with Research & Syllabus for semester-5 & 6 of Botany, (4-year Honours & Honours with Research/ 3-year MDC) under CCF.

The above shall take effect from the Odd semester examinations, 2025 and onwards.

SENATE HOUSE

Kolkata-700073

12.09.2025

A handwritten signature in blue ink, appearing to be 'D 12/9/2025', written over the printed name of the Registrar.

Prof.(Dr.) Debasis Das

Registrar

UNIVERSITY OF CALCUTTA

Course Structure 4-year Honours+Research (NEP 2020) BOTANY

Programme Structure for the Bachelor of Science Degree with BOTANY as Major having Practicals

Sem	DSC/Core	Minor	IDC	AEC	SEC	CVAC	Summer Internship/ Field Visit	Dissertation/ Research work	Total Credit
Level 100									
1	BOT-H-CC1-1- ThBOT-H-CC1- 1-P Plant diversity	Plant diversity (Th+Pr)	Plants Around Us**	From Central Pool	BOT-H-SEC-1- ThBOT-H-SEC-1- P Mushroom Cultivation Technology	1. ENVS 2. CV			21
2	BOT-H-CC2-2- ThBOT-H-CC2- 2-P Plant Systematics	Plant Systematics (Th+Pr)		From Central Pool	BOT-H-SEC-2- ThBOT-H-SEC-2- P Biofertilizer & Biopesticides	1. ENVS 2. Central Pool	Summer Internship***		21
Level 200									
3	BOT-H-CC3-3- ThBOT-H-CC3- 3-P Economic Botany	Plant diversity (Th+Pr)		From Central Pool	BOT-H-SEC-3- ThBOT-H-SEC-3- P Plant Tissue Culture and Hort icultural Practices		Exit option		21
	BOT-H-CC4-3- ThBOT-H-CC4-3- P Plant Anatomy and Embryology								
4	BOT-H-CC5-4- ThBOT-H-CC5-4- P Phycology	Plant Systematics (Th+Pr)		From Central Pool					22
	BOT-H-CC6-4- ThBOT-H-CC6- 4-P Archegoniates								
	BOT-H-CC7-4- ThBOT-H-CC7- 4-P Palaeobotany								
	BOT-H-CC8-4- ThBOT-H-CC8-4- P Pharmacognosy and Ethnobotany						Summer Internship***		
Level 300									
							Exit option		

5	BOT-H-CC9-5- ThBOT-H-CC9-5- P Mycology	Economic Botany (Th+Pr) & Pharmacognosy and Ethno botany (Th+Pr)							24
	BOT-H-CC10-5- ThBOT-H-CC10-5- P Microbiology								
	BOT-H-CC11-5- ThBOT-H-CC11-5- P Biochemistry								
	BOT-H-CC12-5- ThBOT-H-CC12-5- P Cell and Molecular Biology								
6	BOT-H-CC13-6- ThBOT-H-CC13- 6-P Phytopathology	Economic Botany (Th+Pr) & Pharmacognosy and Ethno botany (Th+Pr)							23

	BOT-H-CC14-6-Th CC14-6-P Plant Physiology								
	BOT-H-CC15-6-Th CC15-6-P Genetics						Summer Internship ***		
	Level 400				Exit option				
7	BOT-H-CC16-7-Th BOT-H-CC16-7-P Plant Geography, Ecology and Evolution							Natural Resource Management* (Th+Pr)	20
	BOT-H-CC17-7-Th BOT-H-CC17-7-P Plant Breeding								
	BOT-H-CC18-7-Th BOT-H-CC18-7-P Plant Biotechnology								
	BOT-H-CC19-7-Th BOT-H-CC19-7-P Plant Metabolism								
8	BOT-H-CC20-8-Th BOT-H-CC20-8-P Biostatistics							Stress Biology* (Th+Pr)	20
	BOT-H-CC21-8-Th BOT-H-CC21-8-P Research Methodology-1							Industrial Microbiology* (Th+Pr)	
	BOT-H-CC22-8-Th BOT-H-CC22-8-P Research Methodology-2								
Credits	88	32	9	8	12	8	3	12	172
Marks	2200 [#]	800 [#]	225 ^{##}	200	300 [#]	200	75	300	4300

*Candidates who will not pursue Dissertation/ Research work, he/she will have to study 1 additional DSC/Core paper of 4 credits in the 7th Semester & 2 DSC/Core papers of 4 Credits each in the 8th Semester.

**IDC offered from Botany to be opted in 1st or 2nd or 3rd semester.

***Summer internship once in 2nd or 4th or 6th Semester according to the exit option.

[#]For 100 marks paper 75 marks for theory and 25 marks for practical.

^{##} For 75 marks paper 50 marks for theory and 25 marks for practical.

Minor courses will come from two subjects of same broad discipline as Major (m1 & m2)

Students shall study two papers from a single Minor subject (both either from m1 or from m2) in semester-V and shall study two papers from another Minor subject (both either from m1 or from m2) in semester VI.

Semester V

MYCOLOGY (THEORY)

BOT-H-CC9-5-Th

Total marks 75; Credits 3, Class 45 hours

1. Hyphal forms; Thallus organization; fungal cell structure; Reproduction (Asexual and sexual) and degeneration of sex; Fungal spore forms and mode of liberation; Life cycle patterns; Affinities with plants and animals; Classification proposed by Hawksworth et al. (1995) and Hibbett et al. (2007) (A brief outline); Fungal DNA Barcoding – a tool for molecular identification. **.....8 lectures**
2. Chytridiomycota: General characteristics; Zygomycota: General characteristics; Ascomycota: General characteristics, types of ascocarps, sexual reproduction and development of ascus and ascospores; Basidiomycota: General characteristics, phenomenon of dikaryotization, development of basidiocarps, basidia and basidiospores; Allied Fungi: occurrence, General characteristics, types of plasmodia; Oomycota: General characteristics; Life cycle of *Synchytrium*, *Rhizopus*, *Ascobolus*, *Agaricus*, and *Phytophthora*. **.....12 lectures**
3. Physiology of spore dormancy, activation, and germination; Fungal nutrition; Nutrition uptake; Growth of Fungi, Environmental factors influencing growth; Chitin and Trehalose synthesis in fungi; Fungal secondary metabolites; An outline of polyketides biosynthesis. **.....8 lectures**
4. Mitotic and meiotic cell division in fungi; Tetrad analyses (*Neurospora*), sexual compatibility; Sex hormones in fungi; Parasexual cycle; Linear plasmid in fungi (Structure and function); Fungal protoplast, Genetic transformation of filamentous fungi. **.....9 lectures**
5. Food and beverages from fungi (fungi to enhance food value- Cheese, Soy sauce; wine, beer and spirit, Fungi as functional food and nutraceuticals); Mycoprotein (*Fusariumvenenatum*); Industrial Production of alcohol and citric acid; Mycoremediation. **.....8 lectures**

MYCOLOGY (PRACTICAL)

BOT-H-CC9-5-P

Total marks 25; Credit 1, Class 30 hours

1. Work out	10 marks
2. Identification with reasons	5 marks
3. Classroom performance (Practical notebook)	3 marks
4. Field notebook	2 marks
5. Viva-voce	5 marks

1. Introduction to basic Mycological Techniques and Laboratory Safety; Methods of sterilization, media preparation and culturing.
2. Isolation of fungi from soil/air by the culture plate technique.
3. Work out the following fungi with reproductive structures (including microscopic measurement of Reproductive structures): *Rhizopus*, *Ascobolus*, *Agaricus*, *Aspergillus*, *Alternaria/ Fusarium*.
4. Hyphal types from poroid fungi.
5. Ethanol production.
6. Identification of specimens from the field trip.

CLASSROOM PERFORMANCE

1. Laboratory Note book,
2. Slides (permanent) prepared during practical classes.
3. Submission of 5 Macrofungi and field note book.

Suggested Readings

1. Webster, J. and Weber, R. (2007) Introduction to Fungi. 3rd edition. Cambridge University Press, Cambridge.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (2007) Introductory Mycology, 4th edition, John Wiley & Sons (Asia) Singapore.
3. Chelin Rani Gnanam (2021) Introduction to Mycology, MJP Publisher
4. Jim Deacon (2005) Fungal Biology, Wiley-Blackwell
5. Punshi S. K. Fungal infections with Color Atlas, 1st Edition, Jaypee Brothers Medical Publishers Pvt. Ltd
6. Duane R. Hospenthal, Michael G. Rinaldi, Thomas J. Walsh (2023) Diagnosis and Treatment of Fungal Infections, Springer Nature
7. Aneja, K.R. and Mehrotra R.S. (2015) An Introduction to Mycology, New Age International Private Limited

8. Gopinath Hait (2017) A Textbook of Mycology, New Central Book Agency
9. Thomas Carrey (2022) Mycology: A Comprehensive Approach, States Academic Press
10. Deacon, J. W. (1988). Introduction to Modern mycology, Wiley–Blackwell.
11. Dube, H.C. (2013). A Text Book of Fungi, 4th Edition. Scientific Publishers (India)
12. Moore, C.J.– Landecker (1996) Fundamentals of the Fungi, 4th Edition (1996), Prentice Hall.
13. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.
14. Zhiqiang An (2004) Handbook of Industrial Mycology, Taylor & Francis Inc
15. Kale, V and Bhusari, K (2021). Applied Microbiology. Himalaya Publishing House, Mumbai.

MICROBIOLOGY (Theory)

(BOT-H-CC10-5-Th)

Total marks 75; Credits 3, Class 45 hours

1. Introduction to Microbiology: Introduction to microbial world. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus William Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner;

Systems of bacterial classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms, Systematics of bacteria, Nutritional types [Definition and examples]. Isolation of pure cultures, Types of culture media, maintenance and preservation of bacterial cultures. Distinguishing features of Archaea and Bacteria. Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae, mycoplasma. **.....8 lectures**

2. General Microbiology: Bacterial growth curve and generation time, Methods of Measurement of bacterial growth, batch, fed batch, continuous and synchronous growth. Physico-chemical factors influencing bacterial growth. Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria, Endospore - formation, structure and function, Flagella (ultrastructure) & Pili,

Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation – F- factor, $F^+ \times F^-$, Hfr $\times F^-$, concept of F', chromosome mobilization, (c) Transduction – Generalised and specialised. Plasmids, types and function, their application in modern biology. CRISPR-CAS. **.....10 lectures**

3. Economic Importance: Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents.

Microbes in phyllosphere, water- fresh and marine and air. Microbial interactions- symbiosis, synergism, commensalism, parasitism, amensalism, antagonism and predation. A general account of Endophytes and their interaction with host.

Microbial spoilage of foods – meat, milk, fruits, vegetables and their products; Food poisoning and Food borne pathogenic bacteria- Salmonellosis, Botulism, Cholera, E.coli –poisoning.**10 lectures**

4. Medical Microbiology: Control of Microbes: Physical agents- Sunlight, Temperature, steam at atmospheric pressure and steam under pressure, irradiation, filtration.

Chemical Agents- Alcohol, aldehyde, Dyes, Halogens, Phenols, Ethylene oxide.

Principles of chemotherapy, general mode of action of various chemotherapeutic agents: Sulfa drugs, antibiotics- classification and mode of action.

Normal microbial flora of the human body. **7 lectures**

5. Virus: Viruses:- Discovery, physiochemical and biological characteristics; One step growth curve. Baltimore Classification, General structure with special reference to viroids and prions;

Replication (general account); Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage), Significance of lysogeny,

Plant virus- types, Transmission and translocation of Plant virus, *Symptoms, Causal organism, Disease cycle and Control measures of Potato Virus Y (PVY), Cauliflower Mosaic Virus (CaMV)*

Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics.**10 lectures**

MICROBIOLOGY (Practical)

(BOT-H-CC10-5-P)

Total marks 25; Credit 1, Class 30 hours

1. Work out	10 marks
2. Identification with reasons	5 marks
3. Classroom performance (Practical notebook)	5 marks
4. 5. Viva-voce	5 marks

1. Principles and application of Laboratory instruments- laminar air flow, incubator, autoclave, and incubator shaker.
2. Preparation of Nutrient agar slant, stab, agar plate and nutrient broth and inoculation of bacteria
3. Pure culture techniques: streaking and serial dilution of bacteria from soil, air / water.
4. Bacterial staining- single and mixture of bacteria: Grams staining and negative staining. Study of morphology, Gram Identification and comparison of the results.
5. Pure culture techniques: streaking and serial dilution of bacteria from soil, air / water.
6. Growth curve of bacteria by colorimeter.
7. Antibiotic sensitivity assay disc diffusion method.
8. Microbiological analysis of milk by MBRT assay
9. Biochemical characterization: Starch hydrolysis, Casein hydrolysis.

Suggested Readings

1. General Microbiology by R.Y. Stanier, JL Ingrahm, ML Wheelis and PR Painter.
2. Microbiology: Fundamentals and Applications by RM Atlas.
3. General Microbiology by HG Schlegel
4. Introduction to Modern Virology by NJ Dimmock, A J Easton and K N Leppard
5. Basic Virology by EK Wagner, MJ Hewlett, DC Bloom and D Camerini.
6. Microbiology by Prescott L, Harley J, Klein D.
7. Microbiology by pelczarchan and krieg

Biochemistry (Theory)

BOT-H-CC11-5-Th

Total marks 75; Credits 3, Class 45 hours

1. Biochemical Foundations:1.1. Covalent and non-covalent bonds; hydrogen bond; Van der Waals forces; 1.2. Structure and properties of water; 1.3. pH and buffer (inorganic and organic); 1.4. Handerson-Hasselbalchequation; 1.5. Isoelectric point.6 lectures
2. Molecules of life:2.1. Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and polynucleotides , A, B & Zform of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP),Hoogstein base pairing of nucleic acids, Concept of sugar puckering and base stacking; torsion angle and supercoiling of nucleic acid, 2.2. Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins;Protein folding: Leventhal paradox; principles of protein purification, 2.3.Carbohydrates -, Structure of Carbohydrate: stereochemistry – Fischer projection, Haworth perspective, boat and chair conformation, enantiomers and epimers; inverted sugar, derivative sugar 2.4. Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), major classes of storage and structural lipids; fatty acids- saturated and unsaturated; Essential fatty acids; Triacylglycerols structure, functions and properties.20 lectures
3. Enzymology:3.1. Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, 3.2. Enzyme activity and specificity, active site, activation energy, Reaction rate, Mechanism of enzyme action; enzyme inhibition; 3.3. Enzyme kinetics (Michaelis- Menten equation and Lineweaver Burk plot), simple problems on enzyme kinetics.10 lectures
4. Cell membrane:4.1. Membrane chemistry, 4.2. Membrane transport (uniport, symport, antiport), mechanism of ion uptake.5 lectures
5. Signal transduction: Basic concept of signal transduction, receptor-ligand interactions, calcium signalling, Cyclic AMP, G protein, MAP-kinase cascade.5 lectures
6. Bioenergetics - Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as energy currency molecule. Energy rich bonds- phosphoryl group transfer.5 lectures

Biochemistry (Practical)

BOT-H-CC11-5-P

Total marks 25; Credit 1, Class 30 hours

1. Workout on Plant Biochemistry: Quantitative (10) & Qualitative(5)

2. Laboratory notebook (5)

3. Viva (5)

Qualitative:

1. Detection of organic acids: citric, tartaric, oxalic and malic acid from laboratory samples.
2. Detection of carbohydrate and protein from plant samples.
3. Detection of the nature of carbohydrate – glucose, fructose, sucrose and starch from laboratory samples.
4. Detection of Ca, Mg, Fe, S from plant ash sample.

Quantitative:

1. Preparation of solutions and buffers.
2. Estimation of amino-nitrogen by formol titration method (glycine) .
3. Estimation of glucose by Benedicts quantitative reagent.
4. Estimation of catalase activity in different plant samples..
5. Estimation of urease activity in plant samples.
6. Determination of Km value of Urease.
7. Colorimetric estimation of protein by Folin phenol reagent.

Suggested Readings

1. Taiz, L., & Zeiger, E. Plant Physiology (4th ed.), 2006, Sinauer Associates, Inc. Publishers.
2. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
3. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
4. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.

5. Hames, B.D. Bio-Chemistry (2nd ed.) Viva Books.
6. Sackheim, G. Chemistry for Biology Students (5th ed.) 1996, Benjamin/Cummings
7. Heldt, Hans-Walter. Plant Bio-Chemistry (3rd ed.), 2005. Elsevier Academic Press.
8. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pathways 2008, New Central Book Agencies.
9. Mehta, S.L., Lodha, M.L. & Bane, P.V. Recent Advances in Plant Biochemistry, 1989. I.C.A.R.
10. Conn, E.E. and Stumpf, R.R. Outlines of Bio-Chemistry, Latest Ed., Wiley Eastern.
11. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
12. Berg, J.M., Tymoczko, J.L., & Stryer, L., Bio-Chemistry, Latest Ed., Freeman Publ.

Cell and Molecular Biology

BOT-H-CC12-5-Th

Total marks 75; Credits 3, Class 45 hours

Cell Biology

1. Origin and Evolution of Cells:1.1. Evolution of nucleic acid (from PNA to DNA), Concept of RNA world, Ribozymes, First cell, 1.2. Origin of eukaryotic cell (endosymbiotic theory), 1.3. Small RNA-riboswitch, RNA interference, siRNA, miRNA, snRNA, hnRNA- brief idea, 1.4. Organellar DNA (cp- and mt- DNA).....2 lectures

2. Techniques of Study:2.1 Microscopy (Simple, Compound, Fluorescence,Electron-SEM and TEM), 2.2 Spectrophotometry, 2.3 Electrophoresis (Principle and applications of native polyacrylamide gel electrophoresis and SDS PAGE). 2.4 Western blot, Southern blot and Northern blot. 2.5 FISH and GISH
.....6 lectures

3. Nucleus and Chromosome:3.1 Nuclear envelope, nuclear lamina and nuclear pore complex. 3.2 Nucleolus-ultrastructure and ribosome biogenesis. 3.3 Chromatin ultrastructure and DNA packaging in eukaryotic chromosomes (Nucleosome Model). 3.4 Centromere: types, structure and function.
.....4 lectures

4. Cell cycle and its regulation:4.1 Basic introduction to cell cycle: Mitosis and cytokinesis; comparison between plant, animal and yeast cell cycle; chromosome and chromatids positions, structures during pro-meta-ana- telo phase in detail; Spindle pole body organization, duplication, maturation in yeast cell cycle; mitotic check points and role of MPF; proteins involved in cytokinesis- how actomyosin contractile ring forms, matures and constricts in yeast cytokinesis followed by septum formation and generation of two daughter cells.

4.2 Apoptosis, Autophagy and Necrosis: Definition and concept; apoptosis: extrinsic and intrinsic pathways
4.3 Cancer: Development and causes of cancer, Types of cancer. Proto Oncogene, oncogenes-Ras, BCL-2, Tumour suppressor genes-p53, p21 and DNA Repair Gene.
.....8 lectures

Molecular Biology

1. DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes): 1.1 Central Dogma concept, 1.2 Semiconservative DNA replication – mechanism, enzymes involved in DNA replication- DNA polymerase, DNA gyrase, Helicase, Ligase, primase and other accessory proteins, 1.3. Eukaryotic replication with special reference to replication licensing factor, assembly of new nucleosome, telomerase concept, 1.4. Fidelity of DNA replication- prokaryote: nucleotide selection, proofreading, mismatch repair, 1.5 Transcription: concept of prokaryotic and eukaryotic transcription. Steps of initiation, elongation and termination in prokaryotes, RNA editing, Guide RNA, Aminoacylation of tRNA, 1.6 Translation: Difference between prokaryotic and eukaryotic translation. Prokaryotic translation steps- initiation,

elongation and termination. Concept of genetic code- wobble hypothesis; Descipherence of codon.

.....6 lectures

2. Gene Regulation:2.1 Operon: Concept of Lac-operon, 2.2. Positive and negative control.

.....2 lectures

3. Recombinant DNA Technology: 3.1. Recombinant DNA technology, Restriction endonuclease, types and roles, 3.2. Vector (plasmid pBR 322), 3.3. Marker gene and Reporter gene, 3.4. Steps of cloning technique, 3.5. PCR and its application, 3.6. Genomic DNA and cDNA library, DNA fingerprinting and role of DNA Fingerprinting in Forensic Science.

.....4 lectures

Cell and Molecular Biology (Practical)

BOT-H-CC12-5-P

Total marks 25; Credits 1, Class 30 hours

1.	Work out (Major +Minor)	10+5=15
2.	Laboratory Records	5
3.	Viva-voice	5

1. Introduction to basic instruments:

1.1 Introduction to light compound microscope: Identify each part and their usage in the microscope; how to focus live cells (plant cells from onion peels/leaf-like secretia or spinach / E coli/ yeast) under the microscope and perform measurements; use of oil immersion lens; microscopic resolution and numerical apertures.

1.2 Counting cells per unit volume with the help of a haemocytometer (Yeast/pollen grains)

1.3 Accurate pipetting and weighing scale usage: practicing accurate pipetting by setting up different reaction volumes of solution A (water) and solution B (any solution like calcium chloride, magnesium chloride, etc) and then use the weighing scale to check their accuracy.

2. Isolation of plant genomic DNA by the C-TAB method and DNA estimation by UV/colorimetric.

3. Study of the nucleolus through hematoxylin/orcein staining and determination of nucleolar frequency.

4. Estimation of DNA content through DPA staining.

5. Estimation of RNA through the orcinol method.

6. Preparation of models/charts: rolling circle, theta replication, semi-discontinuous replication, prokaryotic RNA polymerase and eukaryotic RNA polymerase II, assembly of spliceosome machinery, splicing mechanism in group I and group II introns, ribozyme and alternative splicing.

Suggested Readings

Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) *Molecular Biology of the Gene*, 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.

Brown TA. *Gene Cloning and DNA Analysis*. Wiley.

David Freifelder. *Molecular Biology*.

Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Sharma, V. K. (1991). *Techniques in microscopy and cell biology*. Tata McGraw-Hill.

Nelson D. L. and Cox M.M. (2008) *Lehninger Principles of Biochemistry*, 5th Edition.

W.H. Freeman and Company.

Scott F Gilbert. *Developmental Biology*, 6th edition. Sunderland (MA): Sinauer Associates; 2000. ISBN-10: 0-87893-243-7

Cell and Molecular Biology: Concepts and Experiments. Gerald Karp.

Semester VI

PHYTOPATHOLOGY (THEORY)

BOT-H-CC13-6-Th

Total marks 75; Credits 3, Class 45 hours

1. The history and development of plant pathology; Disease concept; signs and symptoms; Etiology and causal complex; Primary and secondary inoculum; Infection; Pathogenicity and pathogenesis; Necrotroph and Biotroph; Koch's Postulates; Endemic, Epidemic, Pandemic and Sporadic disease; Disease triangle and pyramid; Disease cycle (monocyclic, polycyclic and polyetic); Plant disease epidemiology.**10 lectures**

2. Pathogenesis- Inoculation; Attachment; Appressorium formation and maturation; Penetration; Role of chemical weapons in pathogenesis (enzymes, toxins and growth regulators); Genetics of plant disease and resistance- Genes and disease; Specialized mechanisms of variability in pathogens; Gene-for-Gene concept.**10 lectures**

3. Plant defense- Preexisting and induced structural and biochemical defense; Recognition of the pathogen by the plant- Elicitors and Plant receptors; Rapid ion flash; Active oxygen species; Pathogenesis-related proteins; Defense through the production of secondary metabolites; Hypersensitive reactions; PTI and ETI.**10 lectures**

4. Symptoms, Causal organism, Disease cycle and Control measures of:
Late blight of Potato; Brown spot of rice; Black stem rust of wheat; Stem rot of jute; Citrus canker; Tobacco Mosaic Disease.**6 lectures**

5. Control of plant diseases: Molecular diagnosis of plant diseases; Plant health legislation; Cultural, chemical and biological control of plant diseases; Integrated pest management; Biotechnology for plant disease control.**9 lectures**

PHYTOPATHOLOGY (PRACTICAL)

BOT-H-CC13-6-P

Total marks 25; Credit 1, Class 30 hours

1. Work out	10 marks
2. Identification with reasons	5 marks
3. Classroom performance (Practical notebook)	3 marks
4. Herbarium specimens of diseases	2 marks
5. Viva-voce	5 marks

1. Sterilization and incubation - principles and uses of instruments, Culture media and their preparation, Preparation of stabs, slants, and pouring of plates.

2. Isolation of the pathogen from diseased tissues.
3. Preparation of pure culture and subculturing.
4. Inoculation of tuber/stem/fruit.
5. Histopathology of Rust of *Justicia*, Loose smut of wheat/False smut of rice, Powdery mildew of cucurbits, White rust of *Amaranthus*. Slides of uredial, telial, pycnial and aecial stages of *Puccinia graminis*.
6. Study of symptoms from herbarium specimens - bacterial diseases: Citrus Canker; Viral diseases: Vein clearing; Fungal diseases: Early and Late blight of potato, Brown spot and blast of rice, Red rot of sugarcane, White rust of *Amaranthus*, Leaf Spot of *Basella*, Powdery mildew of Cucurbits.

CLASSROOM PERFORMANCE

1. Laboratory Note Book of each section must be signed by the respective teacher with the date during practical classes
2. Slides (permanent) prepared during practical classes.
3. Submission (5 Herbarium specimens of diseases)

Suggested Books:

1. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
2. Mehrotra, R.S. and Aggarwal A. (2017). Plant Pathology. McGraw Hill India.
3. Singh, R.S. (2017) Introduction To Principles Of Plant Pathology, Medtech Publishers.
4. Rangaswami, G. (1988) Diseases of crop Plants of India, 3rd edition, Prentice Hall, India.
5. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.
6. Persley, GJ (1996). Biotechnologies and Integrated Pest Management. CAB International, U.K.
7. Sambamurty, AVSS (2006). A Text Book of Plant Pathology. IK International Publishing House Pvt. Ltd., New Delhi.
8. BalajiAglave (2018) Handbook of Plant Disease Identification and Management, CRC Press
9. Tripathi, SK, Bhale, MS, Yadav, VK and Shrivastava, A (2022). Fundamentals of Plant Pathology. Scientific Publishers, India
10. M. Elangovan, Rashmi Nigam, Sankarganesh E, GeetikaSrivastava (2024) Plant Diseases: Diagnosis, Management, and Control, AGPHBooks
11. Gupta, V. K. (2011) Integrated Disease Management And Plant Health, Scientific (Publication)
12. Meena A.K. (2022) Detection And Diagnosis Of Plant Diseases, Scientific Publishers
13. PrahladMasurkar, Adesh Kumar, Vipul Kumar (2025) Applications of Biotechnology in Plant Pathology, CRC Press

Plant Physiology (Theory)

BOT-H-CC14-6-Th

Total marks—75, Credits-3, Class—45 hours

1. Plant-water relations:

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. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement.6 lectures

2. Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.5 lectures

3. Nutrient Uptake and Organic Translocation: Nutrient Uptake --Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.5 lectures

Translocation in the phloem -- Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model and its critical evaluation; Phloem loading and unloading; Source–sink relationship.6 lectures

4. Plant Growth Regulators and Physiology of flowering: Plant growth regulators --Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Mode of action of IAA. Brassinosteroids, Jasmonic acid and Polyamines as PGRs (brief idea).10 lectures

4.2. Physiology of flowering --Photoperiodism, flowering stimulus, Phytochrome, cryptochrome and phototropins- chemical nature and role in photomorphogenesis. low energy responses (LER) and high irradiance responses (HIR), mode of action. Vernalisation – role of low temperature in flowering, Concept of biological clock and biorhythm.8 lectures

5. Dormancy and Senescence: 5.1. Dormancy- Types, Causes and Methods of breaking seed dormancy, Biochemistry of seed germination. Acid growth hypothesis and starch statolith concept of IAA, GA and ABA mediated hormonal regulation of dormancy and germination, Physiology of Senescence and Ageing.5 lectures

Plant Physiology (Practical)

BOT-H-CC14-6-P

(Full marks—25, Credit-1)

- | | |
|---|-----------|
| 1. Plant Physiology experiment (1 major and 1 minor) | 10 +5 =15 |
| 2. Classroom performance (Laboratory records) | 5 |
| 3. Viva- voce | 5 |

Major experiments:

1. Determination of loss of water per stoma per hour.
2. Relationship between transpiration and evaporation.
3. Measurement of osmotic pressure of storage tissue by weighing method.
4. Measurement of osmotic pressure of *Rhoeo* leaf by plasmolytic method.
5. Effect of temperature on absorption of water by storage tissue and determination of Q_{10} .
6. Rate of imbibition of water by starchy, proteinaceous and fatty seeds and effect of seed coat.
7. Determination of rate of transpiration by two surfaces of a leaf.

Minor experiments:

1. Determination of the temperature at which beet root cells lose their permeability.
2. Measurement of Relative water content of a leaf.
3. Determination of seed viability by tetrazolium test
4. Preparation of different concentration of Molar, Molal, Normal and Percent solutions from Stock solution.
5. Determination of stomatal frequency of a leaf.
6. Preparation of buffer (Acetate buffer and Phosphate buffer).

Suggested Books:

1. Taiz, L., & Zeiger, E. Plant Physiology (4th ed.), 2006, Sinauer Associates, Inc. Publishers.
2. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy. Plant Physiology and Development. (6th ed.) Sinauer Associates.
3. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
4. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 1992, Wadsoworth Publishing Company.
5. Wilkins, M.B. Advances Plant Physiology. 1984, ELBS Longman.

6. Davies P.J. (ed.) Plant Physiology: Physiology, Bio-Chemistry & Molecular Biology, Academic Press.
7. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
8. Raman, H. Transport Phenomenon in Plants, 1997. Narosa Publishing House.
9. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
10. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
11. Singhal, G.S. Concepts of Photobiology: Photosynthesis & Photomorphogenesis, 1999. Narosa Publishing House.
12. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.

Genetics (Theory)

BOT-H-CC15-6-Th

Total marks 75; Credits 3, Class 45 hours

- 1. Introduction:** Mendelian genetics and its extension (Modification of Mendelian ratios)
.....2 lectures
- 2. Linkage, Crossing Over, and Gene Mapping:** 2.1. Sex Chromosomes and Chromosomal Aberrations. - Deletion, Duplication, Translocation, and Inversion, 2.2 Linkage and chromosome mapping in Eukaryotes-Complete and incomplete linkage (example), linked gene does not assort independently(example), linkage group, Crossing over, crossing over produces recombination (example), and Molecular mechanism of crossing over(Holliday model), Gene mapping with three-point test cross, detection of middle gene in three-point test cross, calculation of recombination frequencies, Co-efficient of coincidence and interference, mapping function, Problems on gene mapping.
.....5 lectures
- 3.Eukaryotic transcription and translation:** 3.1 Transcription factors and functions, 3.2 Steps of transcription, 3.3 Post-translational modifications (5' capping, polyadenylation, RNA splicing), 3.4 Steps of translation including initiation, elongation, termination, 3.5post Post-translational modifications (phosphorylation, glycosylation, ubiquitination, acetylation, methylation), Importance of PTM in disease.
.....4 lectures
- 4. Mutation, DNA repair and transposition:** 4.1 Point Mutation-Transition, Transversion and Frame shift mutation, 4.2 Molecular mechanisms (tautomerisation, alkylation, deamination, base analogue incorporation, dimerization), DNA repair, transposon (AC-DS system).
.....2 lectures
- 5. Epistasis and Polygenic inheritance in plants:** 5.1 Incomplete inheritance and Codominance; Inter allelic- Complementary gene interaction (9:7) Ex: *Lathyrusodoratus*; Supplementary gene interaction (9:3:4) eg. Grain colour in Maize and (12:3:1); Epistasis - Dominant e.g.: Fruit colour in *Cucurbitapepo*, 5.2 Polygenic inheritance in plants, 5.3 QTL Mapping.
.....3 lectures
- 6.Aneuploidy and Polyploidy:** Types, examples, meiotic behaviour and importance of: Aneuploidy, Polyploidy, Speciation and evolution through polyploidy.
.....2 lectures

7. Autosomal and Sex-linked inheritance: 7.1 Autosomal dominant and recessive pattern of genetic inheritance with examples, 7.2 X-linked inheritance (recessive and dominant with examples and phenotypes. 7.3 Y-linked disorders.2 lectures

8. Genomics and Bioinformatics: 8.1 Basic idea on Whole genome sequencing (WGS), Gene sequencing (dideoxy method and pyrosequencing) 8.2 Use of databases: GenBank, NCBI, 8.3. Introduction to data analysis tools (e.g., BLAST), structure prediction of protein from amino acid sequence through alpha fold, 8.4 Sequence alignment (pairwise and MSA) 8.5. Basic idea on molecular docking.4 lectures

9. Population and evolutionary genetics: Gene pool, Allele frequency, Evolution, Natural selection, Genetic drift, Gene flow.2 lectures

10. Special topics: Genetic testing (carrier screening, prenatal screening), Gene therapy, forensics, GMOs and precision medicine. Transcriptomics and metabolomics.3 lectures

Genetics(Practical)

BOT-H-CC15-6-P

Total marks 25; Credits 1, Class 30 hours

1. Genetics Workout	8 +4
2. Identification	3
3. Classroom performance (Laboratory Records and slides)	5
4. Viva-voice	5

Genetics

1. Introduction to chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.

2. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.

3. Study of mitotic chromosome: Metaphase chromosome preparation, free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of 2n number, and comment on the chromosome morphology of the following specimens from root tips: *Allium cepa*, *Aloe vera*, *Lens esculenta*.

4. Study of chromosomal aberrations developed due to exposure to any one pollutants/ pesticides, etc.
5. Study of meiotic chromosomes: Smear preparation of meiotic cells, identification of different stages and free-hand drawing of the following specimens from flower buds: *Allium cepa* and *Setcreasea* sp.
6. Identification from permanent slides: Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*); Mitosis – (i) normal stages, (ii) abnormal stages early separation, late separation, multipolarity, sticky bridge, laggard, fragmentation, (ii) pollen mitosis.
7. Bioinformatics:
 - 7.1 Gene sequence search from gene bank, primer design through benchling or snapgene and virtual gel run on a computer. Search for homologous gene lists using NCBI BLAST, 7.2. Structural prediction of protein by AlphaFold3 free online website.

Suggested Books:

1. Pierce, Benjamin A. Genetics (2nd ed.), 2005, W.H. Freeman & Company.
2. Atherly, A.G., Girton, J.R. & McDonald, J.F. Science of Genetics, 1999, Saunders College Publications.
3. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. & Veres, R.C. Genetics (2nd ed.), 2004, McGraw-Hill.
4. Tamarin, Robert H. Principles of Genetics (7th ed., 2002, Tata McGraw-Hill.
5. Elrod, S.K. & Stanfield, W. Schuam's Outlines Genetics (4th ed.), 2002, Tata McGraw-Hill.
6. Hartl, D.L. & Jones, E.W. Genetics, 2005, Jones & Bartlett Publishers.
7. Lewin, B. Genes VIII, 2004, Pearson Educational International.
8. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. Molecular Biology of the Gene (5th ed.) 2004. Pearson Education Inc.
9. Griffiths, A.I.F., Miller, J.H., Suzuki, D.T., Lewentin, C.R. & Gilbert, M.W. An Introduction to Genetic Analysis, 2005 (8th ed.), W.H. Freeman & Company.
10. Brown, T.A. Genomes, 1999, John Wiley & Sons.
11. Brown, T.A. Genomes 3, 2007, Garland Science Publishing.
12. Snustad, D.P. & Simmons, M.J. Principles of Genetics (2nd ed.), 2000, (4th ed.), 2006, John Wiley & Sons.
13. Klug, W.S. & Cummings, M.R. Concepts of Genetics, 2003, Pearson Education.

Semester V

PLANT ANATOMY & EMBRYOLOGY (Theory)

MBOT-CC6-5-Th (MDC)

(Total Marks 75, Credits 3, Lectures 45 hours)

PLANT ANATOMY (50 marks)

1. Cell and Tissues: 14 lectures

- 1.1 Cell wall: ultrastructure, chemical constituents; thickening of cell wall.
- 1.2 Tissues: meristems, simple and complex tissues, cambium- Structure and function
- 1.3 Mechanical tissues and the principles governing their distribution in plants.
- 1.4 Stele: stelar types; leaf-trace and leaf-gap, 1.5 Stomata types (Metcalfe and Chalk, 1950; Stebbins and Khush, 1961).

2. Primary and secondary growth: 8 lectures

- 2.1 Primary structure of stem and root- monocot and dicot. Leaf- dorsiventral and isobilateral, 2.2 Secondary growth: normal (intra- & extra-stelar),

3. Developmental and Ecological Anatomy: 6 lectures

- 3.1 Organization of shoot apex (Tunica–Corpus) and root apex (Korper-Kappe), plastochron, 3.2 Adaptive anatomical features of hydrophytes, xerophytes, halophytes.

4. Scope of plant anatomy: 2 lectures

Application in systematics, forensics and pharmacognosy.

EMBRYOLOGY (25 marks)

1. Pre-fertilisation and post-fertilization changes : 10 lectures

- 1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic), 1.3 Pollen germination, 1.4 Double fertilization, post-fertilization changes.

2. Embryo development and apomixis: 5 lectures

- 2.1 Embryogenesis in *Capsella*, 2.2 Development of endosperm (3 types), 2.3 Apomixis- Apospory and Apogamy, 2.4 Polyembryony- different types.

3. Raghavan, V. Embryogenesis in Angiosperms: A Development & Experimental Study, 1986, Cambridge University Press.
4. Bhojwani, S.S. & Bhatnagar, S.D. The Embryology of Angiosperms (4th ed.), 1989, Publishing House.

Semester V (CC1)/ VI (CC2)

Cell biology and Genetics (Theory)

MBOT CC7-5-Th (MDC)

(Candidates can opt for this paper either in Sem V as CC1 or in Sem VI as CC2)

Theoretical – 3 credits (marks 75) 45 lectures

Cell Biology

1. Nucleus and Chromosome:

1.1. Ultrastructure of nuclear envelope, nucleolus and their functions, 1.2. Chromatin ultrastructure and DNA packaging in eukaryotic chromosome (Nucleosome concept). Centromere: types, structure and function. 1.3. Ultrastructure of mitochondria, chloroplast, golgi complex, endoplasmic reticulum and their functions8 lectures

2. Cell cycle and its regulation:

2.1. Kinetochore and spindle apparatus-structural organization and functions, 2.2. Microtubules-structure, organization and function, 2.3. Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), 2.4. Apoptosis (Brief idea).6 lectures

Genetics :

1. Introduction:

1.1. Mendelian genetics and its extension (incomplete dominance, codominance, multiple alleles), 1.2. Epistasis (Dominant and Recessive epistasis) and polygenic inheritance in plants.

... 4 lectures

2. Linkage, Crossing over and Gene Mapping

2.1. Complete and incomplete linkage, linkage group, 2.2. Crossing over, detection of crossing over (McClintock's experiment), 2.3. Molecular mechanism of crossing over (Holliday model), 2.4. Calculation of recombination frequencies, Gene mapping with three point test cross, 2.5. Molecular mapping – ISH, FISH (brief idea) 8 lectures

3. Chromosomal aberrations-

3.1 Deletion, Duplication, Inversion & Translocation, 3.2 Aneuploidy & Polyploidy-types, importance and role in evolution.....4 lectures

4. Central Dogma

4.1 Transcription and Translation. 4.2. Genetic Code – properties. 4 lectures

5. Mutation

5.1 Point mutation (tautomerisation; transition, transversion and frame shift), 5.2 Mutagen-physical and chemical.4 lectures

6. Structural organisation of Gene:

6.1. One Gene–one polypeptide concept, 6.2. Split gene, Overlapping gene, 6.3. Repetitive DNA tandem and interspersed, 6.4. Transposon (Ac-Ds system), 6.5. Homoeotic gene in plants (ABCE Quartet model of flowering).7 lectures

CELL BIOLOGY and GENETICS (PRACTICAL)

MBOT CC7-5-PR (MDC)

1. Work out	10
2. Identification	5
3. Classroom performance (Laboratory Records and slides)	3+2
4. Viva-voce	5

Cell Biology

1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo
2. Measurement of cell size by the technique of micrometry.
3. Study of nucleolus through hematoxylin staining and determination of nucleolar frequency

Genetics

1. Introduction to chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.
2. Study of mitotic and meiotic chromosome: Identification of different stages and free hand drawings from the permanent slides of roots and flower buds: *Allium cepa*
3. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.

Suggested Books:

1. Gupta, P.K. Cytogenetics, Rastogi Publications
2. Guha. J. & Chaudhuri, S.K. , Udvidbigyan: vol. II, Moulik Library (Bengali Version)
3. Jain, H.K. , Genetics , Oxford & IBH Publishing House
4. Kar, D.K. & Halder, S. Cell Biology, Genetics & Molecular Biology , New Central Book Agency

5. Sikdar, J.K., Sen, K. &Giri, P. , PrarambhikUdbhidbidya , Vol II, (Biomolecules and Cell Biology Genetics) , Santra Publication (Bengali Version)
6. Sen, S. &Kar, D. K., Cytology & Genetics , Narosa Publishing House
7. Santra. S.C. , Practical Botany, Vol II, New Central Book Agency

Semester VI

PLANT PHYSIOLOGY AND BIOCHEMISTRY (THEORY)

MBOT-CC8-6-Th (MDC)

(Total Marks 75, Credits 3, Lectures 45 hours)

Plant Physiology

1. Transport in plants and Transpiration

1.1 Ascent of sap and Xylem cavitation, 1.2 Phloem transport and source-sink relation. 1.3 Transpiration-Types, Mechanism of stomatal movement, significance.8 lectures

2. Photosynthesis and Respiration

2.1 Photosynthesis:Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C₃, C₄ and CAM photosynthesis, - Reaction and Significance. 2.2 Respiration: Glycolysis & Krebs cycle— Reactions and Significance, ETS and Oxidative phosphorylation.10 lectures

3. Nitrogen metabolism

Biological dinitrogen fixation, Amino acid synthesis (reductive amination and transamination).4 lectures

4. Plant Growth regulators

Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA.5 lectures

5. Photoperiodism: Plant types, Role of phytochrome and GA in flowering and Vernalization.....4 lectures

6. Senescence (brief idea).....2 lectures

Biochemistry

1. Molecules of life:

1.1 Proteins- Primary, secondary and tertiary structure, classification of amino acids.

1.2 Nucleic acid- DNA structure and types, RNA types,

1.3 Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers.

1.4 Lipids - Simple lipid and compound lipid (phospholipids and glycolipids), fatty acids- saturated and unsaturated.8 lectures

2. **Enzyme** -- Classifications with examples (IUBMB), Mechanism of action....4 lectures

PLANT PHYSIOLOGY AND BIOCHEMISTRY (PRACTICAL)

MBOT-CC8-6-PR(MDC)

Total Marks 25; Credit 1

1.Experiment on Plant Physiology	15 marks
2.Classroom performance: Lab records	5 marks
3. Viva voce	5 marks

Plant Physiology:

- i) Experiment on Plasmolysis.
- ii) Measurement of leaf area (graphical method) and determination of transpiration rate per unit area by weighing method.
- iii) Imbibition of water by dry seeds -starchy, proteinaceous and fatty seeds.
- iv) Determination of evolution of O₂ during photosynthesis (using graduated tube).
- v) Determination of evolution of CO₂ during aerobic respiration.

Suggested Books:

1. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 1992, Wadsworth Publishing Company.
2. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
3. Mehta, S.L., Lodha, M.L. & Bane, P.V. Recent Advances in Plant Biochemistry, 1989. I.C.A.R.
4. Conn, E.E. and Stumpf, R.R. Outlines of Bio-Chemistry, Latest Ed., Wiley Eastern.
5. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.