



**BACHELOR OF SCIENCE (HONOURS)-BOTANY
CURRICULUM AND SYLLABI**

(For students admitted for the academic year 2018-19)

**Sri Ramasamy Memorial University, Sikkim
5th Mile, Tadong, Gangtok, Sikkim 737102**

Semester	Discipline specific core course (DSC)	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC)	Discipline specific elective course (DSE)	Ancillary
I	1. Microbiology and Phycology	English-I (LSRW)			Chemistry
	2. Plant Morphology and Plant Systematics				
II	3. Mycology and Phytopathology	English-II Communication			Chemistry
	4. Archegoniate and Palaeobotany				
III	5. Plant Anatomy		Ethnobotany		Zoology
	6. Economic Botany				
	7. Plant Genetics				
IV	8. Molecular Biology		Herbal Technology		Zoology
	9. Plant Ecology and Phytogeography				
	10. Biomolecules and Cell Biology				
V	11. Reproductive Biology of Angiosperms			Horticultural Practices and Post-Harvest Technology OR Bioinformatics	
	12. Plant Physiology				
VI	13. Plant Metabolism			Industrial and Environmental Microbiology OR Biostatistics	
	14. Plant Biotechnology				

B.Sc. (Honours) Botany Curriculum

Course category	Course code	Course Name	L	T	P	C
SEMESTER-I						

L	LAE1811	English-I(LSRW)	2	1	0	3
C	BOT1812	Microbiology and Phycology	4	0	0	4
C	BOT1813	Plant Morphology and Plant Systematics	4	0	0	4
A	CHM1812	Structure and Bonding in Chemistry	4	0	0	4
C-P	BOT1814	Microbiology and Phycology-Practical	0	0	4	2
C-P	BOT1815	Plant Morphology and Plant Systematics-Practical	0	0	4	2
A-P	CHM1814	Inorganic Qualitative Analysis-Practical	0	0	4	2
*SWAYAM	EVS1817	Environmental Studies (Internal Evaluation)				
		TOTAL			12	21
SEMESTER-II						
Course category	Course code	Course Name	L	T	P	C
L	LAE1821	English-II (Communication Skill)	2	1	0	3
C	BOT1822	Mycology and Phytopathology	4	0	0	4
C	BOT1823	Archegoniate and Palaeobotany	4	0	0	4
A	CHM1823	Basic Concepts of Organic Chemistry	4	0	0	4
C-P	BOT1824	Mycology and Phytopathology-Practical	0	0	4	2
C-P	BOT1825	Archegoniate-Practical	0	0	4	2
A-P	CHM1844	Laboratory Course on Methods and Synthesis in Organic Chemistry	0	0	4	2
Extension	EX*will be S/C/Y	NSS / NCC /Yoga (Internal Evaluation)				
		TOTAL			12	21
SEMESTER-III						
Course category	Course code	Course Name	L	T	P	C
C	BOT1831	Plant Anatomy	3	0	0	3
C	BOT1832	Economic Botany	3	0	0	3
C	BOT1833	Plant Genetics	3	0	0	3
A	ZOLA1831	Animal Diversity	3	0	0	3
S	BOT1834	Ethnobotany	2	0	0	2
C-P	BOT1835	Plant Anatomy-Practical	0	0	4	2
C-P	BOT1836	Economic Botany-Practical	0	0	4	2
C-P	BOT1837	Plant Genetics-Practical	0	0	4	2
A-P	ZOLA1832	Animal Diversity-Practical	0	0	4	2
		TOTAL			16	22
SEMESTER-IV						
Course category	Course code	Course Name	L	T	P	C
C	BOT1841	Molecular Biology	3	0	0	3
C	BOT1842	Plant Ecology and Phytogeography	3	0	0	3
C	BOT1843	Biomolecules and Cell Biology	3	0	0	3
A	ZOLA1841	Aquatic Biology	3	0	0	3
S	BOT1844	Herbal Technology	2	0	0	2
C-P	BOT1845	Molecular Biology-Practical	0	0	4	2
C-P	BOT1846	Plant Ecology and Phytogeography-Practical	0	0	4	2
C-P	BOT1847	Biomolecules and Cell Biology-Practical	0	0	4	2
A-P	ZOLA1842	Aquatic Biology-Practical	0	0	4	2
		TOTAL			16	22
SEMESTER-V						
Course category	Course code	Course Name	L	T	P	C
C	BOT1851	Reproductive Biology of Angiosperms	4	0	0	4
C	BOT1852	Plant Physiology	4	0	0	4
E1	BOT1853	Horticultural Practices and Post-Harvest Technology	4	0	0	4
E2	BOT1854	Bioinformatics				
C-P	BOT1855	Reproductive Biology of Angiosperms-Practical	0	0	4	2

C-P	BOT1856	Plant Physiology-Practical	0	0	4	2
E1-P	BOT1857	Horticultural Practices and Post-Harvest Technology-Practical	0	0	4	2
E2-P	BOT1858	Bioinformatics-Practical				
		TOTAL			12	18
SEMESTER-VI						
Course category	Course code	Course Name	L	T	P	C
C	BOT1861	Plant Metabolism	4	0	0	4
C	BOT1862	Plant Biotechnology	4	0	0	4
E1	BOT1863	Industrial and Environmental Microbiology	4	0	0	4
E2	BOT1864	Biostatistics				
C-P	BOT1865	Plant Metabolism-Practical	0	0	4	2
C-P	BOT1866	Plant Biotechnology and Bioinformatics-Practical	0	0	4	2
E1-P	BOT1867	Industrial and Environmental Microbiology-Practical	0	0	4	2
E2-P	BOT1868	Biostatistics-Practical				
		TOTAL			12	18

A-Ancillary

A-P-Ancillary Practical

C-Core

C-P-Core Practical

E1 and E2-Discipline Specific Elective Course

L-LSRW (Listening Speaking Reading and Writing)

S-Skill Enhancement Course

*These courses are suggested to complete through online SWAYAM and credit will be displayed on the mark sheet.

SEMESTER-I

Course code	Course Name	L	T	P	C
LAE1811	English-I (LSRW)	2	1	0	3

UNIT I: Listening Skills

Introduction to Communication-LSRW

Active Listening

Reasons for poor Listening

Types of Listening

Barriers to Listening

Traits of a good Listener

Activity: Listening to the news and making notes, listening to announcements, listening to speeches, listening to instructions and summarizing them, listening to and differentiating pronunciations.

UNIT II: Speaking Skills

Importance of Speaking Skills

Effective Speaking-Confidence, Clarity and Fluency

Types of Speaking-Task Oriented-Interpersonal-Formal and Semi Formal

Persuasive Speaking and Public Speaking

Barriers to Speaking

Guidelines for conducting a Group Discussion

Guidelines for conducting a Meeting

Activity: Peer Introduction, JAM, Public speech, Role play, Product description, debate, GD, paneldiscussion, Conducting Meeting

UNIT III: Reading Skills

Introduction to Reading skills

Thesis, Evidence, Evaluation

Topic sentence and its role

Types of reading-Intensive-Extensive-Skimming-Scanning

Reading and its purposes

Reading for pleasure

Reading for critical interpretation

Reading for note making and summarizing

Activity: Reading articles and short stories and verbally summarizing them, reading newspapers and magazines and highlighting the content, reading comprehensions, reading reviews, reading and interpreting the content, identifying the thesis-evidence-evaluation, reading novels (Abridged version).

UNIT IV: Writing Skills

Introduction and Importance of Writing

Writing a Sentence

Writing a Paragraph-Topic Sentence, illustration

Characteristics of Writing-Clarity-Accuracy-Correctness-Descriptiveness

Language-Appropriateness-Conciseness-Flow

Business Writing-Basic principles of Business Communication

Letter writing-Thank you and follow-up letter, complaint letter, inquiry letter, invitation letter, letter to the editor

Writing memo, notice, agenda and minutes of the meeting

Report writing

Interpretation of data (flow charts, figures and pictures)

Essay and Article Writing

Poster Making

Activity- Writing a paragraph, Writing different kinds of letters, framing notices and memos and agendas, jotting down minutes of the meeting, reporting an event or the work done, interpreting various pictures, figures and data.

UNIT V: Basic Grammar

Tense and Articles

Prepositions

Direct and Indirect Speech

Active and Passive Voice

Course category	Course code	Course Name	L	T	P	C
C	BOT1812	Microbiology and Phycology	4	0	0	4

UNIT I: Microbes

Bacteria-Discovery, general characteristics and cell structure; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Microbial growth, nutrition and metabolism; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine). Viruses: Discovery, General characteristics, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

UNIT II: Algae

General characteristics; Classification (system of Fritsch); Distribution; Range of thallus organization; Cell structure and components; Cell wall, pigments, reserve food, flagella; methods of reproduction; criteria; Evolutionary classification of Lee (only upto groups).

UNIT III: Cyanophyta and Xanthophyta

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

UNIT IV: Chlorophyta and Charophyta

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

UNIT V: Phaeophyta and Rhodophyta

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia*.

Text Books

1. Kumar, H.D. (1999). *Introductory Phycology*, 2nd edition. Affiliated East-West Press Pvt. Ltd. Delhi.
2. Dubey, R.C. and Maheshwari, D.K. (2009). *A Text Book of Microbiology*, 1st Edition. S. Chand Publication.
3. Mitra, D., Guha, J. and Chowdhury, S.K. *Studies in Botany: Volume I*. Moulik Library.
4. Gangulee, H.C. and Kar, A.K. (1989). *College Botany: Volume II: 3rd* Reprint 2010, New Central Book Agency (P) Limited.
5. Banerjee, A.K. and Banerjee, N. (2008). *Fundamentals of Microbiology & Immunology*. New Central Book Agency (P) Limited.

Reference Books

1. Lee, R.E. (2008). *Phycology*, 4th edition. Cambridge University Press, Cambridge.
2. Black, J.G. and Black, J.L. (2015). *Microbiology: Principles and Explorations*, 9th Edition.
3. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2013) *Prescott's Microbiology*, 9th Edition. McGrawHill International.
4. Tortora, G.J., Funke, B.R. and Case, C.L. (2010). *Microbiology: An Introduction*, 10th edition, Pearson Benjamin Cummings, U.S.A.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V. and Jackson R.B. (2008). *Biology*, 8th edition. Pearson Benjamin Cummings, USA.
6. Pelczar, M.J. (2001). *Microbiology*, 5th edition, Tata McGraw-Hill Co, New Delhi.

Course category	Course code	Course Name	L	T	P	C
C	BOT1813	Plant Morphology and Plant Systematics	4	0	0	4

UNIT I: Seed Plants and Angiosperm Morphology

Leaf: Morphology and phyllotaxy; Flower: Type and structure. Morphology of stamen and carpel; Pollination, Double fertilization; Inflorescence; Types and examples. Fruits and seeds: General concepts, type and dispersal. Seed Plants: Characteristics of seed plants with fruits (Angiosperm) and without fruits (Gymnosperms). Angiosperm: Origin and evolution. Some examples of primitive angiosperms.

UNIT II: Significance of Plant Systematics

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. Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species

concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

UNIT III: Systems of Classification

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III)classification.

UNIT IV: Biometrics, Numerical Taxonomy, Cladistics

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

UNIT V: Phylogeny of Angiosperms

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Text Books

1. Sharan, S. (2011). *Plant Morphology*.
2. Singh, B.D. *Concept in Plant Morphology*, Anmol Publication (P) Limited.

Reference Books

1. Singh (2012). *Plant Systematics: Theory and Practice*, 3rd edition, Oxford & IBH Pvt. Ltd., New Delhi.
2. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A. and Stevens, P.F. (2002). *Plant Systematics- A Phylogenetic Approach*, 2nd edition, Sinauer Associates Inc., U.S.A.
4. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.

Course category	Course code	Course Name	L	T	P	C
A	CHM1812	Structure and Bonding in Chemistry	4	0	0	4

UNIT I: Atomic Structure

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wavefunctions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number. (14 Lectures)

UNITII: Periodicity of Elements

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.

- Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
- Atomic radii (van der Waals)
- Ionic and crystal radii.
- Covalent radii (octahedral and tetrahedral)
- Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
- Electron gain enthalpy, trends of electron gain enthalpy.
- Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio. (16 Lectures)

UNITIII: Chemical Bonding

(i) *Ionic bond*: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) *Covalent bond*: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2 , O_2 , C_2 , B_2 , F_2 , CO, NO, and their ions; HCl, BeF_2 , CO_2 , (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(iii) *Metallic Bond*: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iv) *Weak Chemical Forces*: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment)

Effects of chemical force, melting and boiling points, solubility energetics of dissolution process. (26 Lectures)

UNITIV: Oxidation-Reduction

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class. (4 Lectures)

Text Books

1. Shriver, D.F., Atkins, P.W. and Langford, C.H. (2001). *Inorganic Chemistry*, 3rd edition, Oxford University Press, London.
2. Douglas, B., McDaniel, D. and Alexander, J. (1994). *Concepts and Models of Inorganic Chemistry*, 3rd edition, John Wiley.
3. Lee, J.D. (2008). *Concise Inorganic Chemistry*, 5th edition, Wiley.
4. Atkins, P.W and Paula, J. D. (2009). *Physical chemistry*, 9th Oxford University Press.

Reference Books

1. Purcell, K.F and Kotz, J.C. (1976). *Inorganic Chemistry*, Saunders, Philadelphia.
2. Moeller, T. (1990). *Inorganic Chemistry: A Modern Introduction*, Wiley, New York.
3. Puri, B.R., Sharma, L.R. and Kalia, K.C. (1996). *Principles of Inorganic Chemistry*, Shoban Lal Nagin Chand and Co.
4. Huheey, J.E., Keiter, E.A. and Keiter, R.L. (1983). *Inorganic Chemistry*, 4th edition, Harper and Row, New York.
5. Day, M.C. and Selbin, J. (1962). *Theoretical Inorganic Chemistry*, ACS Publications.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1814	Microbiology and Phycology-Practical	0	0	4	2

1. Microscopy- handling of microscope, study on the functions of different parts of microscope.
2. T-Phage and TMV- Electron micrographs pictures only.
3. Lytic and Lysogenic cycle- Line drawing only.
4. Types of Bacteria to be observed from permanent slides and photographs.
5. Study of bacterial binary fission, endospore formation, conjugation, root nodule by electron micrographs photograph.
6. Gram staining technique.
7. Endospore staining with malachite green using (endospores taken from soil bacteria).
8. Study of vegetative and reproductive structures and temporary slide preparation of fresh algal specimens of *Nostoc*, *Chlamydomonas*, *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*, *Vaucheria*, *Ectocarpus*, *Fucus*, *Polysiphonia* and *Prochloron*. Study form permanent slide.

Practical Text Books

1. Santra, S.C., Chatterjee, T.P. and Das, A.P. (2010). *College Botany Practical, Volume I*. New Central Book Agency (P) Limited.
2. Santra, S.C., Chatterjee, T.P. and Das, A.P. (2010). *College Botany Practical: Volume II*. New Central Book Agency (P) Limited.
3. Santra, S.C. (2015). *Practical Botany-Volume II*. New Central Book Agency (P) Limited.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1815	Plant Morphology and Plant Systematics-Practical	0	0	4	2

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham and Hooker's system of classification): Ranunculaceae, Brassicaceae, Myrtaceae, Umbelliferae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Poaceae.
2. Field visit (local)-Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in Central Harbarium room in the University).

Practical Books

1. Singh G. *Plant Systematics: Theory and Practice*. Publisher: Oxford and IBH-PUBS Company, New Delhi.
2. Sinha, R.K. (2013). *Practical-Taxonomy of Angiosperms*.

Course category	Course code	Course Name	L	T	P	C
A-P	CHM1814	Inorganic Qualitative Analysis-Practical	0	0	4	2

Semi micro qualitative analysis

Qualitative analysis of a mixture containing **two anions** and **two cations**.

Analysis of a mixture containing **two cations** and **two anions** of which one will be an interfering ion.

Anions: Carbonate, sulphate, chloride, bromide, acetate, nitrite, nitrate, borate, chromate, oxalate, tartrate, and phosphate.

Cations: Lead, bismuth, copper, cadmium, antimony, iron, zinc, cobalt, nickel, manganese, calcium, strontium, barium, & ammonium, silver, magnesium, mercury.

Reference Books

1. Ramanujam, V.V. (1974). *Inorganic Semi Micro Qualitative Analysis*, 3rd edition, The National Publishing Company, Chennai.
2. Vogel's *Text Book of Inorganic Qualitative Analysis*, 4th edition (1974), ELBS, London.
3. Venkateswaran, V., Veerasamy, R. and Kulandaivelu, A.R. (1997). *Basic Principles of Practical Chemistry*, 2nd edition, S. Chand & Sons, New Delhi.
4. Gurtu, J.N. and Kapoor, R. (2010). *Advanced Experimental Chemistry*, 6th edition, S. Chand and Co.

SEMESTER-II

Course category	Course code	Course Name	L	T	P	C
L	LAE1821	English-II (Communication Skill)	2	1	0	3

UNIT I: Understanding Communication

Introduction to Communication

Definition

Communication process

Methods of Communication-Internal and External

Communication Networks of Communication-Vertical

horizontal- diagonal

Barriers of Communication-Linguistic, Psychological, Interpersonal, cultural, physical and organizational.

(R.C. Sharma and Krishna Mohan, *Business Correspondence*, pages 34-43)

UNIT II: Technology-based Communication Aids

Telephone and voicemails

Facsimile Machines

Internet and computers

Emails

Conferencing

Instant Messaging

Groupware

NETTIQUETTE

Positive and Negative Impact of Technology enabled communication

Effectiveness in Technology based communication

UNIT III: Verbal and Non-Verbal Communication

Verbal Communication

Conversation-importance-essentials-conversation management-non-verbal cues in conversation-

Oral Presentation Skills-Technical aids in Visual Communication

(Shirley Taylor, V. Chandra, *Communication for Business—A practical Approach*, 4th edition, page no. 378-397)

Team Presentation

Non-verbal Communication

Definition and Significance

Significance of Non-verbal Signals in organizations

Types of Non-verbal communication- Kinesics- Paralinguistic- Proxemics and Chronemics

UNITIV: Interviews

Introduction- Objectives of Interviews

Types of interviews

Job Interviews-cover Letter-Resume Writing-Preparation for Interview-Interviewing Process-Mock Interview
 Medium of Interview-Telephonic interview-web interview
 (Meenakshi Raman, Sangeeta Sharma, *Technical Communication-Principles and practices*, pg. no 180-203).

UNITV: Cross Cultural Communication

Introduction
 Concept of Cross-Cultural Communication
 Ethnocentrism
 Cultural Variables and Communication Sensitivity
 Variables of National Culture
 Cross- Cultural Communication Strategies
 Potential Hot Spots in Cross-Cultural Communication
 Cross-Cultural Communication Skills-Basic Tips

Course category	Course code	Course Name	L	T	P	C
C	BOT1822	Mycology and Phytopathology	4	0	0	4

UNITI: General Account of Fungi

Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification; Chytridiomycetes: General account; Zygomycota: General characteristics; Ecology; Thallusorganisation; Life cycle with reference to *Rhizopus*; Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces, Aspergillus, Penicillium, Alternaria, Neurospora* and *Peziza*; Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

UNIT II: Allied Fungi

General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

UNIT III: Oomycota

General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo*.

UNITIV: Symbiotic Associations

Lichen-Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction. Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

UNITV: Applied Mycology

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

UNIT VI: Phytopathology

Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host-Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial Diseases-Citrus canker and angular leaf spot disease of Cotton. Viral Diseases-Tobacco Mosaic viruses, vein clearing. Fungal Diseases-Early blight of potato, Black stem rust of wheat, white rust of crucifers.

Text Books

1. Aneja, K.R. (2015). *An Introduction to Mycology*, 2nd edition, New Age International (P) Limited.
2. Saxena, S. (2012). *Textbook of Mycology*, 5th edition, Sonali Publications.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). *Introductory Mycology*, 4th edition, John Wiley & Sons (Asia) Singapore.
4. Sethi, I.K. and Walia, S.K. (2011). *Text book of Fungi and Their Allies*, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). *Plant Pathology*, Rastogi Publication, Meerut, India.

Reference Books

1. Agrios, G.N. (2005). *Plant Pathology*, 5th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). *Introductory Mycology*, 4th edition, John Wiley & Sons (Asia) Singapore.
3. Webster, J. and Weber, R. (2007). *Introduction to Fungi*, 3rd edition, Cambridge University Press, Cambridge.

Course category	Course code	Course Name	L	T	P	C
C	BOT1823	Archegoniate and Palaeobotany	4	0	0	4

UNIT I: Introduction

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

UNIT II: Bryophytes

General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family). *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 III: Pteridophytes

General characteristics, classification, early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory and seed habit, telome theory, stelar evolution. Ecological and economic importance.

UNITIV: Gymnosperms

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

UNIT V: Palaeobotany

Contributions of Birbal Sahni in Indian Palaeobotany. Introduction, importance of Paleobotany. Definition of fossil, process of fossilization, types of fossils on the basis of their preservation; concept of Form Genus, conditions for fossilization. Origin of life, Geologic Time Scale, major events of plant life through geologic time.

Text Books

1. Rashid, A. (2016). *An Introduction to Archigoniata Plants*. Vikas Publishing.
2. Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). *Pteridophyta*, S. Chand Publication, Delhi, India.
3. Mitra, D., Guha, J. and Chowdhury, S.K. *Studies in Botany: Volume I*. Moulik Library.
4. Bhatnagar, S.P. and Moitra, A. (1996). *Gymnosperms*. New Age International (P) Ltd Publishers, New Delhi, India.

Reference Book

1. Shaw, A.J. and Goffinet, B. (2000). *Bryophyte Biology*, Cambridge University Press.
2. Santra, S.C., Chatterjee, T.P. and Das, A.P. (2010). *College Botany Practical, Volume I*. New Central Book Agency (P) Limited.
3. Stewart, W.N. and Rathwell, G.W. (1993). *Paleobotany and the Evolution of Plants*. Cambridge University Press.
4. Taylor Thomas N., Taylor E.L. and Michael, K. (2009). *Palaeobotany-The Biology and Evolution of Fossil Plants*. Academic Press, Elsevier.

Course category	Course code	Course Name	L	T	P	C
A	CHM1823	Basic Concepts of Organic Chemistry	4	0	0	4

UNIT I: Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations,

Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. (6 Lectures)

UNITII: Stereochemistry

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. (18 Lectures)

UNITIII: Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1c reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2- and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

C. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams. (24 Lectures)

UNITIV: Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups. (12 Lectures)

Text Books

1. Graham Solomons, T.W. (1996). *Organic Chemistry*, 6th edition, John Wiley and Sons, New York.
2. Wade, L.G. (2016). *Organic Chemistry*, 8th edition, Pearson.
3. Kalsi, P.S (2005). *Stereochemistry Conformation and Mechanism*; New Age International.
4. Eliel, E.L. and Wilen, S.H. (1994). *Stereochemistry of Organic Compounds*; Wiley: London.

Reference Books

1. Pine, S.H. (1987). *Organic Chemistry*, 5th edition, McGraw Hill, New York.
2. Ege, S.N. (1998). *Organic Chemistry Structure and Reactivity*, 3rd edition, A.I.T.B.S., New Delhi.
3. Carey, F.A. (1999). *Organic Chemistry*, 3rd edition, Tata-McGraw Hill Publications, New Delhi.
4. Paula, B.Y. (2002). *Organic Chemistry*, 3rd edition, Pearson Education Inc., Singapore.
5. Clayden, J., Greeves, N. and Warren, S. (2014). *Organic Chemistry*, 2nd edition, Oxford.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1824	Mycology and Phytopathology-Practical	0	0	4	2

1. *Rhizopus*, *Aspergillus* and *Penicillium*- study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. *Peziza*: sectioning through ascocarp and preparation of temporary mounts.
3. *Alternaria*: Specimens study from temporary mounts.
4. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections and mounts of spores on wheat and permanent slides of both the hosts.
5. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*.
6. Study of phanero plasmodium and sporangia of *Stemonitis* from photograph.
7. *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section and temporary mounts and sexual structures through permanent slides.
8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates (field collection). Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs).
9. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1825	Archegoniate-Practical	0	0	4	2

1. *Riccia*-Morphology of thallus; *Marchantia*-Morphology of thallus, whole mount of rhizoids and Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
2. *Anthoceros*-Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
3. *Pellia*, *Porella*-Study through permanent slides; *Sphagnum*-Morphology of plant, whole mount of leaf (permanent slide only).
4. *Funaria*-Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.

5. *Psilotum*-Study of specimen, transverse section of synangium (permanent slide).
 6. *Selaginella*-Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide); *Equisetum*-Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
 7. *Pteris*-Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
 8. *Cycas*-Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide); *Pinus*-Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal/transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section and radial longitudinal sections stem (permanent slide).
 9. *Gnetum*-Morphology (stem, male and female cones), transverse section of stem, vertical section of ovule (permanent slide).
- Botanical Excursion-Special class on field tour, Survey, collection of plants, precautionary measures (Practical perspectives).

Practical Text Book

Santra, S.C., Chatterjee, T.P. and Das, A.P. (2010). *College Botany Practical: Volume II*. New Central Book Agency (P) Limited.

Course category	Course code	Course Name	L	T	P	C
A-P	CHM1844	Laboratory Course on Methods and Synthesis in Organic Chemistry	0	0	4	2

1. Qualitative organic functional group analysis-tests for alcohols, phenols, amines, carbonyls, carboxylic acids and nitro compounds.
2. Preparation of organic compounds: Dibenzylidene acetone, Aromatic sulphonation, Nitration of acetanilide, Bromination of acetanilide (Green Synthesis)
3. Purification techniques: recrystallization, sublimation, distillation and steam distillation.
4. Thin layer chromatography, column chromatography & paper chromatography.
5. Preparation of soap - saponification.
6. Preparation of methyl orange and aspirin.
7. Specific rotation of chiral compounds (sugars) using a polarimeter.
8. Plotting of molecular orbitals of aromatic compounds and conjugated systems.

9. Conformational analysis-butane and substituted butanes, cyclohexane and di-substituted cyclohexane with stress on *cis* and *trans* isomerism.

10. Molecular modelling:

a) Stereo-chemistry: R-S configuration.

b) Modeling on hybridization, geometry of some organic & inorganic compounds.

Reference Books

1. Pavia, D.L., Lampman, G.M. and Kriz, G.S. (1982). *Introduction to Organic Laboratory Techniques*, 2nd edition, Saunders College Publishing.

2. Singh, P.R., Gupta, D.S. and Bajpai, K.S. (1980). *Experimental Organic Chemistry: Volume I and II*, Tata McGraw Hill.

3. *Vogel's Text Book of Qualitative Organic Analysis* (1994), 5th edition, ELBS.

4. Athawale, V.D and Mathur, P. (2001). *Experimental Physical Chemistry*, New Age International Publishers.

SEMESTER-III

Course category	Course code	Course Name	L	T	P	C
C	BOT1831	Plant Anatomy	3	0	0	3

UNIT I: Scope of Plant Anatomy

Applications in systematics, forensics and pharmacognosy.

UNIT II: Structure and Development of Plant Body

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. 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 III: Meristems and Anatomical Structures

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, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Rootcap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

UNIT IV: Vascular Cambium and Wood

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

UNIT V: Adaptive and Protective Systems

Epidermal tissue system, cuticle, epicuticular waxes, trichomes (unicellular and multicellular, glandular and non-glandular, two examples of each), stomata (classification); Adcrustation and incrustation;

Anatomical adaptations of xerophytes and hydrophytes.

Text Books

1. Pandey, B.P. (2012). *Plant Anatomy*. S. Chand Publication Pvt. Ltd.
2. Mitra, D., Guha, J. and Chowdhury, S.K. *Studies in Botany: Volume I*. Moulik Library.

Reference Books

1. Mauseth, J.D. (1988). *Plant Anatomy*. The Benjamin/Cummings Publisher, USA.
2. Cutler, D.F., Stevenson, D.W. and Botha, C.E.J. (2008). *Plant Anatomy: An Applied Approach*. John Wiley & Sons. Blackwell Publishing.

Course category	Course code	Course Name	L	T	P	C
C	BOT1832	Economic Botany	3	0	0	3

UNIT I: Origin of Cultivated Plants

Concept of centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

UNIT II: Cereals, Legumes, Sugars and Starches

Wheat and Rice (origin, morphology, processing and uses), brief account of millets. General account of legumes, its importance to man and ecosystem. Sugars and Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato-morphology, propagation and uses.

UNIT III: Spices

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

UNIT IV: Oils, Fats and essential oils

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

UNIT V: Other Economically Important Plants

Beverages: Tea, Coffee (morphology, processing and uses). Natural Rubber: Para-rubber: tapping, processing and uses. Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*. Tobacco: Tobacco (Morphology, processing, uses and health hazards). Timber plants: General account with special reference to teak and pine. Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).

Text Books

1. Kochhar, S.L. (2012). *Economic Botany in Tropics*, MacMillan & Co. New Delhi, India.
2. Sammbamurthy, A.V.S.S. (2008). *A Textbook of Modern Economic Botany*, 1st Edition, CBS Publication.
3. Umrani, R. (2009). *Basics of Economic Botany*, Anmol Publication.

Reference Book

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

Course category	Course code	Course Name	L	T	P	C
C	BOT1833	Plant Genetics	3	0	0	3

UNIT I: Extension of Mendelian Genetics

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.

UNIT II: Extrachromosomal Inheritance

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective Heredity-Kappa particles in *Paramecium*.

UNIT III: Linkage, Crossing over and Chromosome mapping

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

UNIT IV: Variation in Chromosome Number and Structure

Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.

UNIT V: Gene Mutations and Fine Structure of Gene

Types of mutations; Molecular basis of Mutations; Mutagens-physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms. Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

UNIT VI. Population and Evolutionary Genetics

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection mutation, genetic drift. Genetic variation and Speciation.

Text Books

1. Mahabal, R. (2010). *Fundamentals of Cytogenetics and Genetics*, 1st edition, PHI learning Pvt. Limited, New Delhi.
2. Mitra, D., Guha, J. and Chowdhury, S.K. *Studies in Botany* Volume I. Moulik Library.

Reference Books

1. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*, 5th edition, John Wiley & Sons Inc., India
2. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991). *Principles of Genetics*, 8th edition, John Wiley & sons, India.
3. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009). *Concepts of Genetics*, 9th edition, Benjamin Cummings, U.S.A.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. (2010). *Introduction to Genetic Analysis*, 10th edition, W. H. Freeman and Co., U.S.A.

Course category	Course code	Course Name	L	T	P	C
A	ZOLA1831	Animal Diversity	3	0	0	3

UNIT I: Protista, Porifera, Radiata, Aceolomates, Pseudocoelomates

General characters of Protozoa; Life cycle of *Plasmodium*

General characters and canal system in Porifera

General characters of Cnidarians and polymorphism

General characters of Helminthes; Life cycle of *Taeniasolium*

General characters of Nemethehelminthes; Parasitic adaptations

UNIT II: Coelomate Protostomes, Arthropoda, Mollusca, Coelomate, Deuterostomes

General characters of Annelida; Metamerism

General characters. Social life in insects.

General characters of mollusca; Pearl Formation

General characters of Echinodermata, Water Vascular system in Starfish.

UNIT III: Protochordata

Salient features

UNIT IV: Diversity of Chordates

Osmoregulation, Migration of Fishes

General characters, Adaptations for terrestrial life, parental care in Amphibia.

Amniotes; Origin of reptiles. Terrestrial adaptations in reptiles.

The origin of birds; Flight adaptations

UNIT V: Mammalia

Early evolution of mammals; Primates; Dentition in mammals

Text book

1. Jordan, E.L. and Verma, P.S. *Invertebrate Zoology*. New edition Edition, S. Chand Publications.
2. Jordan, E.L. and Verma P.S. *Chordate Zoology*. New edition Edition, S. Chand Publications.
3. Kotpal, R.L. *Modern Textbook of Zoology-Invertebrates*, Rastogi Publications.
4. Kotpal, R.L. *Modern Textbook of Zoology-Vertebrates*, Rastogi Publications.

Reference book

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.I.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science.

Course category	Course code	Course Name	L	T	P	C
S	BOT1834	Ethnobotany	2	0	0	2

UNIT I: Ethnobotany

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

UNIT II: Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

UNIT III: Role of Ethnobotany in Modern Medicine

Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) a) *Azadirachta indica* b) *Ocimum sanctum* c) *Vitex negundo* d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

UNIT IV: Conservation of Plant Genetic Resources

Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

UNIT V: Ethnobotany and Legal Aspects

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1835	Plant Anatomy-Practical	0	0	4	2

1. Study of anatomical details of root, stem and leaves through permanent slides.
2. Study of the anomalous structures of stems of the following genera: *Bignonia*, *Dracaena*, *Boerhaavia* and *Strychnos*.
3. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
4. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
5. Microscopic identification of the followings: Primary structure of Sunflower and maize stem and gram and Canna root, Bulliform cells, stomatal types, lenticels, raphides (acicular and sphaeraphides), cystolith.
6. Maceration of wood elements of Cucurbita and Pinus stem and their microscopic examination.
7. Root: monocot, dicot, secondary growth.
8. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
9. Leaf: isobilateral, dorsiventral, C₄ leaves (Kranz anatomy).
10. Adaptive Anatomy: xerophytes, hydrophytes.
11. Secretory tissues: cavities, lithocysts and laticifers.

Practical Book

1. Rajan, S.S. (2003). Practical Manual of Plant Anatomy and Embryology. Anmol Publication.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1836	Economic Botany-Practical	0	0	4	2

1. Cereals: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests) Rice(habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. Sugars and Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. Spices: Black pepper, Fennel and Clove (habit and sections).
5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. Oils and Fats: Coconut-T.S. nut, Mustard-plant specimen, seeds; tests for fats in crushed seeds.
7. Essential oil-yielding plants: Habit sketch of *Rosa*, *Vetiveria*, *Santalum* and, Eucalyptus (photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of *Digitalis*, *Papaver* 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), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

Practical Book

1. Pandey, S.N and Chadha, A. (1993). *A Text Book of Botany: Plant Anatomy and Economic Botany*, Volume 3. Vikash Publishing House Pvt Ltd.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1837	Plant Genetics-Practical	0	0	4	2

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

Reference Books

1. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991). *Principles of Genetics*, 8th edition, John Wiley & Sons, India.
2. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*, 5th edition, John Wiley & Sons Inc., India.
3. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009). *Concepts of Genetics*, 9th edition, Benjamin Cummings, U.S.A.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. (2010). *Introduction to Genetic Analysis*, 10th edition, W. H. Freeman and Co., U.S.A.

Course category	Course code	Course Name	L	T	P	C
A-P	ZOLA1832	Animal Diversity-Practical	0	0	4	2

1. Study of following specimens:

Non Chordates: *Euglena*, *Noctiluca*, *Paramecium*, *Sycon*, *Physalia*, *Tubipora*, *Metridium*, *Taenia*, *Ascaris*, *Nereis*, *Aphrodite*, *Leech*, *Peripatus*, *Limulus*, Hermitcrab, *Daphnia*, Millipede, Centipede, Beetle, *Chiton*, *Dentalium*, *Octopus*, *Asterias*, and *Antedon*.

Chordates: *Balanoglossus*, *Amphioxus*, *Petromyzon*, *Pristis*, *Hippocampus*, *Labeo*, *Ichthyophis/Uraeotyphlus*, *Salamander*, *Rhacophorus Draco*, *Uromastix*, *Naja*, *Viper*, model of *Archaeopteryx*, any three common birds- (Crow, duck, Owl), Squirrel and Bat.

2. Study of following Permanent Slides: Cross section of *Sycon*, Sea anemone and *Ascaris* (male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva.

3. Temporary mounts of (a) Septal and pharyngeal nephridia of earthworm (b) Unstained mounts of Placoid, cycloid and ctenoid scales.

4. Dissections of (a) Digestive and nervous system of Cockroach (b) Urinogenital system of Rat.

Practical Books

1. Verma, P.S. *A Manual of Practical Zoology: Chordates*, 10th Revised edition, Kindle Edition, S. Chand Publication.
2. Verma, P.S. *A Manual of Practical Zoology Invertebrates*, Kindle Edition, S. Chand Publication.

SEMESTER IV

Course category	Course code	Course Name	L	T	P	C
C	BOT1841	Molecular Biology	3	0	0	3

UNIT I: Nucleic Acids: Carriers of Genetic Information

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey and Chase, Avery, McLeod and McCarty, Fraenkel-Conrat's experiment). The Structures of DNA and RNA/Genetic Material: 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 Structure; Organelle DNA-mitochondria and chloroplast DNA. The Nucleosome; Chromatin structure-Euchromatin, Heterochromatin-Constitutive and Facultative heterochromatin.

UNIT II: Replication of DNA

Chemistry of DNA synthesis (Kornberg's discovery); General principles-bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5' end of linear chromosome; Enzymes involved in DNA replication.

UNIT III: Central Dogma and Genetic Code

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

UNIT IV: Transcription

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

UNIT V: Processing and Modification of RNA and Translation

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' polyA tail); Ribozymes; RNA editing and mRNA transport. Translation: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Text Books

1. Malacinski, G.M. (2015). *Freifelder's Essentials of Molecular Biology*, 4th edition. Jones and Bartlett India Private Limited.
2. Powar, C.B. (2010). *Cell Biology*, Himalaya Publishing House.
3. Arumugam, N. (2014). *Molecular Biology*.

Reference Books

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2007). *Molecular*

- Biology of the Gene*, 6th edition, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A.
2. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*, 5th edition, John Wiley and Sons Inc., U.S.A.
 3. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009). *Concepts of Genetics*, 9th edition Benjamin Cummings. U.S.A.
 4. Russell, P.J. (2010). *i-Genetics- A Molecular Approach*, 3rd edition, Benjamin Cummings, U.S.A.
 5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. (2010). *Introduction to Genetic Analysis*, 10th edition, W. H. Freeman and Co., U.S.A.

Course category	Course code	Course Name	L	T	P	C
C	BOT1842	Plant Ecology and Phytogeography	3	0	0	3

UNIT I: Introduction

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

UNIT II: Environmental Components

Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development. Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

UNIT III: Biotic Interactions

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. Population ecology: Characteristics and Dynamics. Ecological Speciation. Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession-processes, types; climax concepts.

UNIT IV: Ecosystems

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

UNIT V: Phytogeography

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

Text Books

1. Sharma, P.D. (2010). *Ecology and Environment*, 8th edition, Rastogi Publications, Meerut, India.
2. Singh, J.S., Singh, S.P. and Gupta, S. (2006). *Ecology Environment and Resource Conservation*. Anamaya Publications, New Delhi, India.

3. Kormondy, E.J. (1996). *Concepts of Ecology*, 4th edition, PHI Learning Pvt. Ltd., Delhi, India.

Reference Books

1. Odum, E.P. (2005). *Fundamentals of Ecology*, 5th edition. Cengage Learning India Pvt. Ltd., New Delhi.
2. Singh, J.S., Singh, S.P. and Gupta, S. (2006). *Ecology Environment and Resource Conservation*. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). *Ecology and Environment*, 8th edition. Rastogi Publications, Meerut, India.
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*, 4th edition, PHI Learning Pvt. Ltd., Delhi, India.

Course category	Course code	Course Name	L	T	P	C
C	BOT1843	Biomolecules and Cell Biology	3	0	0	3

UNIT I: Biomolecules

Types of chemical bonds; Structure and properties of water; pH and buffers. Nomenclature and classification of carbohydrates. Major classes of structural and storage lipids; Fatty acids structure and functions; Essential fatty acids; Triacylglycerols structure, functions and properties; Phosphoglycerides. Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins. Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

UNIT II: Bioenergetics

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

UNIT III: Enzymes

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), Michaelis-Menten equation, enzyme inhibition and factors affecting enzyme activity.

UNIT IV: The Plant Cell

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport- Passive, active and facilitated transport, endocytosis and exocytosis.

UNIT V: Cell Organelles

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes: structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endoplasmic Reticulum-Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus-organization, protein glycosylation, protein sorting and export from Golgi apparatus; Lysosomes.

UNIT VI: Cell Division

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

Text Books

1. Mali, N.S., Tembhurne, R.R., Shinde, S.S., Bhise, D.S. and Satpute, S.M. *Biomolecules and Cell Biology*.
2. Mitra, D., Guha, J. and Chowdhury, S.K. *Studies in Botany: Volume II*. Moulik Library.
3. Rastogi, S.C. (2005). *Cell Biology*. New Age International Publication.

Reference Books

1. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. 5th edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Karp, G. (2010). *Cell Biology*, 6th edition, John Wiley & Sons, U.S.A.
3. Nelson, D.L. and Cox, M.M. (2008). *Lehninger-Principles of Biochemistry*, 5th Edition, W.H. Freeman and Company.
4. Hardin, J., Becker, G. and Skliensmith, L.J. (2012). *Becker's World of the Cell*, 8th edition. Pearson Education Inc. U.S.A.
5. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011). *Biochemistry*, W.H. Freeman and Company.

Course category	Course code	Course Name	L	T	P	C
A	ZOLA1841	Aquatic Biology	3	0	0	3

UNIT I: Aquatic Biomes

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT II: Freshwater Biology

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous. Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT III: Marine Biology

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT IV: Management of Aquatic Resources

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, management and conservation (legislations), Sewage treatment, Water quality assessment-BOD and COD.

Course category	Course code	Course Name	L	T	P	C
S	BOT1844	Herbal Technology	2	0	0	2

UNIT I: Herbal Medicines

History and scope-definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation-harvesting-processing-storage-marketing and utilization of medicinal plants.

UNIT II: Pharmacognosy

Systematic position medicinal uses of following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry.

UNIT III: Phytochemistry

Active principles and methods of their testing-identification and utilization of the medicinal herbs; *Catharanthus roseus*(cardiotonic), *Withaniasomnifera*(drugs acting on nervous system), *Clerodendron phlomoides*(anti-rheumatic) and *Centella asiatica*(memory booster).

UNIT IV: Analytical Pharmacognosy

Drug adulteration-types, methods of drug evaluation-Biological testing of herbal drugs-Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

UNIT V: Micropropagation of Medicinal Plants

Medicinal plant banks micro propagation of important species (*Withaniasomnifera*, neem and tulsi- Herbal foods-future of pharmacognosy).

Text Books

1. Kokate, C.K., Purohit, A.P. and Gokhle, S.B. (1999). *Pharmacognosy*, NiraliPrakashan.
2. Arber, A. (1999). *Herbal Plants and Drugs*. Mangal Deep Publications.

Reference Books

1. Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). *Glossary of Indian Medicinal Plants*. C.S.I.R., New Delhi.

- Kanny, Lall, Dey and Raj Bahadur (1984). *The Indigenous Drugs of India*. International Book Distributors.
- Arber, A. (1999). *Herbal Plants and Drugs*. Mangal Deep Publications.
- Sivarajan, V.V. and Indra, B. (1994). *Ayurvedic Drugs and Their Plant Source*. Oxford IBH publishing Co.
- Light, M. and Bryan, M. (1998). *Ayurveda and Aromatherapy*. Banarsidass, Delhi.
- Green, A. (2000). *Principles of Ayurveda*, Thomsons, London.
- Kokate, C.K., Purohit, A.P. and Gokhle, S.B. (1999). *Pharmacognosy*, NiraliPrakashan.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1845	Molecular Biology-Practical	0	0	4	2

- Preparation of LB medium and raising *E. coli*.
- Isolation of genomic DNA from *E. coli*.
- DNA isolation from cauliflower head.
- DNA estimation by diphenylamine reagent/UV Spectrophotometry.
- Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
- Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
- Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel&Conrat's experiments)
- Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Practical Books

- Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2007). *Molecular Biology of the Gene*, Pearson Benjamin Cummings, 6th edition, CSHL Press, New York, U.S.A.
- Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*, 5th edition, John Wiley and Sons Inc., U.S.A.
- Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009). *Concepts of Genetics*, 9th edition. Benjamin Cummings. U.S.A.
- Russell, P.J. (2010). *i-Genetics- A Molecular Approach*, 3rd edition, Benjamin Cummings, U.S.A.
- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. (2010). *Introduction to Genetic Analysis*, 10th edition, W. H. Freeman and Co., U.S.A.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1846	Plant Ecology and Phytogeography-Practical	0	0	4	2

- Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
- Determination of pH of various soil and water samples (pH meter, universal indicator and pH paper)

3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the University campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the University campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the University campus.
11. Field visit to familiarize students with ecology of different sites.

Reference Books

1. Odum, E.P. (2005). *Fundamentals of ecology*, 5th edition. Cengage Learning India Pvt. Ltd., New Delhi.
2. Singh, J.S., Singh, S.P. and Gupta, S. (2006). *Ecology Environment and Resource Conservation*. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). *Ecology and Environment*, 8th edition, Rastogi Publications, Meerut, India.
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*, 4th edition, PHI Learning Pvt. Ltd., Delhi, India.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1847	Biomolecules and Cell Biology-Practical	0	0	4	2

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of onion (*Allium cepa*).
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer using bacterial cell.
6. Study of cell and its organelles with the help of electron micrographs photographs.
7. Study the phenomenon of plasmolysis and deplasmolysis.
8. Study the effect of organic solvent and temperature on membrane permeability.
9. Study of different stages of mitosis and meiosis from root tip and flower bud of *Allium cepa*.

Practical Text Books

1. Santra, S.C., Chatterjee, T.P. and Das, A.P. (2010). *College Botany Practical, volume I*. New Central Book Agency (P) Limited.

2. Santra, S.C. (2015). *Practical Botany-Volume I*. New Central Book Agency (P) Limited.
3. Pandey, B.P. (2005). *Modern Practical Botany-Volume-I*, S. Chand Publication.

Practical Reference Book

1. Wallis, C.J. (1966). *Practical Botany: For Advanced Level and Intermediate Students*. 5th Edition. Imprint: Butterworth-Heinemann.

Course category	Course code	Course Name	L	T	P	C
A-P	ZOLA1842	Aquatic Biology-Practical	0	0	4	2

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates and bicarbonates) in water collected from a nearby lake/water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine bio-reserve/Fisheries Institutes.

SEMESTER-V

Course category	Course code	Course Name	L	T	P	C
C	BOT1851	Reproductive Biology of Angiosperms	4	0	0	4

UNIT I: Introduction

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

UNIT II: Reproductive Development

Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects. Anther and pollen biology: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia. Ovule: 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 III: Pollination and Fertilization

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. Self-incompatibility: 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 IV: Embryo, Endosperm and Seed

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

UNIT V: Polyembryony and Apomixis

Introduction; Classification; Causes and applications.

Text Books

- Johri, B.M. and Srivastava, P.S. (2001). *Reproductive Biology of Plants*, 1st edition, Narosa Publishing House.
- Bhojwani, S.S. and Bhatnagar, S.P. (2011). *The Embryology of Angiosperms*, 5th edition, Vikas Publishing House, Delhi.

Reference Books

- Shivanna, K.R. (2003). *Pollen Biology and Biotechnology*. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
- Raghavan, V. (2000). *Developmental Biology of Flowering plants*, Springer, Netherlands.
- Johri, B.M. (1984). *Embryology of Angiosperms*, Springer-Verlag, Netherlands.

Course category	Course code	Course Name	L	T	P	C
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C	BOT1852	Plant Physiology	4	0	0	4
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UNIT I: 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, anti-transpirants, mechanism of stomatal movement.

UNIT II: Mineral Nutrition and Nutrient Uptake by Plants

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. 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 III: Translocation in the Phloem

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

UNIT IV: Plant Growth Regulators

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

UNIT V: Physiology of Flowering

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Text Books

1. Salisbury and Ross (2006). *Plant Physiology*, 1st edition, Cbs Publication.
2. Pandey, S.N. and Sinha, B.K. (2005). *Plant Physiology*, 4th edition, S. Chand Publication.

Reference Books

- Hopkins, W.G. and Huner, A. (2008). *Introduction to Plant Physiology*, 4th edition. John Wiley and Sons, U.S.A.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2015). *Plant Physiology and Development*, 6th edition Sinauer Associates Inc., USA.

Course category	Course code	Course Name	L	T	P	C
E1	BOT1853	Horticultural Practices and Post-Harvest Technology	4	0	0	4

UNIT I: Introduction Horticultural Plants

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism. Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (*Opuntia*, *Agave* and *Spurges*)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coral tree).

UNIT II: Fruit and Vegetable Crops and Flowering Plants

Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits). Floriculture: Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.

UNIT III: Horticultural Techniques

Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations. Landscaping and garden design: Planning and layout (parks and avenues); gardening traditions- Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

UNIT IV: Post-harvest Technology

Importance of post-harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation; Food irradiation- advantages and disadvantages; food safety.

UNIT V: Disease Control and Management

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices; Identification of common diseases and pests of ornamentals, fruits and vegetable crops.

UNIT VI: Horticultural Crops-conservation and Management

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

Course category	Course code	Course Name	L	T	P	C
E2	BOT1854	Bioinformatics	4	0	0	4

UNIT I: Introduction to Bioinformatics

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

UNITII: Databases in Bioinformatics

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System. Biological Sequence Databases: National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

UNITIII: Sequence Alignments

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

UNITIV: Molecular Phylogeny

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

UNITV: Applications of Bioinformatics

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1855	Reproductive Biology of Angiosperms-Practical	0	0	4	2

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
3. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (photographs, fresh material), ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test. germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. 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.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1856	Plant Physiology-Practical	0	0	4	2

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.
9. Demonstration experiments
 - a) To demonstrate suction due to transpiration.
 - b) Fruit ripening/Rooting from cuttings (Demonstration).
 - c) Bolting experiment/Avena coleoptile bioassay (demonstration).

Practical Reference Book

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

Course category	Course code	Course Name	L	T	P	C
E1-P	BOT1857	Horticultural Practices and Post-Harvest Technology-Practical	0	0	4	2

1. Field trip: Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at IARI or other suitable locations.
2. Preparation of different manures: Preparation of EM compost, green manure, vermicompost.
3. Nursery and field management techniques.

Practical Books

1. Kumar, M.K. (2016). *Practical Manual of Horticulture*, 1st edition, Bioech Publication.
2. Prasad, V.M. and Vikram, B. (2018). *Practical Manual on Fundamentals of Horticulture and Plant Propagation*, 1st edition, Write and Print Publications.

Course category	Course code	Course Name	L	T	P	C
E2-P	BOT1858	Bioinformatics-Practical	0	0	4	2

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Reference Books

1. Ghosh, Z. and Bibekanand M. (2008). Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell, A. M., Heyer, L. J. (2006). Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

SEMESTER-VI

Course category	Course code	Course Name	L	T	P	C
C	BOT1861	Plant Metabolism	4	0	0	4

UNIT I: Concept of Metabolism

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

UNIT II: Carbon Assimilation

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO₂ reduction, photorespiration, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction.

UNIT III: Carbohydrate Metabolism and Lipid Metabolism

Synthesis and catabolism of sucrose and starch. Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaerobic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration. ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyer's conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers. Lipid metabolism: Synthesis and breakdown of triglycerides, β -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

UNIT IV: Nitrogen Metabolism

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

UNIT V: Mechanisms of Signal Transduction

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

Text Books

1. Mitra, D., Ghua, J. and Mitra, J.N. *Studies in Botany: Volume II*, Moulik Library, Calcutta.

Reference Books

- Hopkins, W.G. and Huner, A. (2008). *Introduction to Plant Physiology*, 4th edition. John Wiley and Sons, U.S.A.
- Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2015). *Plant Physiology and Development*, 6th edition, Sinauer Associates Inc., USA.
- Harborne, J.B. (1973). *Phytochemical Methods*. John Wiley & Sons, New York.

Course category	Course code	Course Name	L	T	P	C
C	BOT1862	Plant Biotechnology	4	0	0	4

UNIT I: Plant Tissue Culture

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

UNIT II: Recombinant DNA technology

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

UNIT III: Gene concept and DNA libraries

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

UNIT IV: Applications of Biotechnology

Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moon dust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products-Human Growth Hormone; Humulin; Biosafety concerns

Text books

1. Satyavathi, C.T, Bharadwaj, C., Srivastava, SK, Anand, G.R. and Prasad, S.V. S. (2014). *Biotechnology*, 2nd edition, New Vishal Publication.
2. Chawla, H.S. (2008). *Introduction to Plant Biotechnology*, 3rd edition, Oxibh Publication.
3. Umesha, S., (2005). *Plant Biotechnology*. The Energy and Resources Institute Publication.

Reference Books

1. Bhojwani, S.S. and Razdan, M.K., (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R. and Pasternak, J.J. (2003). *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 and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). *Plant Biotechnology & Genetics: Principles, Techniques and Applications*. John Wiley & Sons Inc. U.S.A.

Course category	Course code	Course Name	L	T	P	C
E1	BOT1863	Industrial and Environmental Microbiology	3	0	2	4

UNIT I: Scope of Microbes in Industry and Environment

Bioreactors/Fermenters and fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilot scale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

UNIT II: Microbial Production of Industrial Products

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; 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 III: Microbial Enzymes of Industrial Interest and Enzyme Immobilization

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

UNIT IV: Microbes and Quality of Environment

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

UNIT V: Microbes in Agriculture and Remediation of Contaminated soils

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

Reference Books

1. Pelzar, M.J. Jr., Chen E.C. S. and Krieg, N.R. (2010). *Microbiology: An Application Based Approach*. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R. and Case. C.L. (2007). *Microbiology*, 9th. Pearson Benjamin Cummings, edition San Francisco, U.S.A.

Course category	Course code	Course Name	L	T	P	C
E2	BOT1864	Biostatistics	3	0	2	4

UNIT I: Biostatistics

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

UNIT II: Collection of Data Primary and Secondary

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

UNIT III: Measures of Central Tendency

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

UNIT IV: Correlation

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

UNIT V: Statistical Inference

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

UNIT VI: (Practical based)

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.

Reference Books

1. Danniel, W.W. (1987). *Biostatistic*, New York, John Wiley Sons.
2. Sundarrao, P.S.S and Richards, J. Christian. *An introduction to Biostatistics*, 3rd edition, Medical College, Vellore.
3. Selvin, S. (1991). *Statistical Analysis of Epidemiological data*, New York University Press.
4. Freedman, P. *The Principles of scientific research*, Pergamon Press, New York.
6. Campbell, R.C. (1998). *Statistics for Biologists*. Cambridge University Press.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1865	Plant Metabolism-Practical	0	0	4	2

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.

- To compare the rate of respiration in different parts of a plant.
- To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
- To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
- Demonstration of fluorescence by isolated chlorophyll pigments.
- Demonstration of absorption spectrum of photosynthetic pigments.

Course category	Course code	Course Name	L	T	P	C
C-P	BOT1866	Plant Biotechnology-Practical	0	0	4	2

- (a) Preparation of MS medium (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
- Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis and artificial seeds through photographs.
- Isolation of protoplasts.
- Construction of restriction map of circular and linear DNA from the data provided.
- Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
- Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.
- Isolation of plasmid DNA; Restriction digestion and gel electrophoresis of plasmid DNA.

Practical books

- Giri, CC. and Giri, A. (2007). *Plant Biotechnology: Practical Manual*. I.K. International Publication.
- Plant Biotechnology Practical Manual*, SRM University.

Course category	Course code	Course Name	L	T	P	C
E1-P	BOT1867	Industrial and Environmental Microbiology-Practical	0	0	4	2

- Principles and functioning of instruments in microbiology laboratory
- Hands on sterilization techniques and preparation of culture media.
- A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

Course category	Course code	Course Name	L	T	P	C
E2-P	BOT1868	Biostatistics-Practical	0	0	4	2

- Calculation of mean, standard deviation and standard error
- Calculation of correlation coefficient values and finding out the probability
- Calculation of 'F' value and finding out the probability value for the F value
