M.Sc. Botany

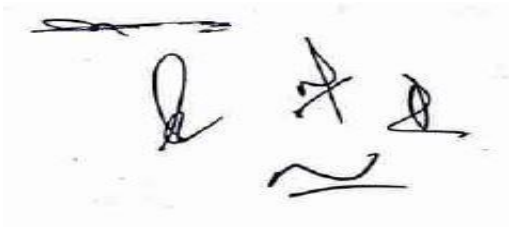
Scheme A2: Semester 1st

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A01	Algae & Fungi	261/BOT/CC101	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A02	Molecular Biology	261/BOT/CC102	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A03	Cell Biology	261/BOT/CC103	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-01	Biostatistics and Data Analysis OR Genetic Engineering	261/BOT/DS101	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-01	One from the Pool	261/BOT/MD101	02	00	02	02	00	01	03	15	35	05	20	**75**
Ability Enhancement Course(s)														
AEC-01	One from the Pool		02	00	00	02	00	00	02	00	50	00	00	**50**
Value-added Course(s)														
VAC-01	One from the Pool	261/BOT/VA101	02	00	00	02	00	00	02	15	35	00	00	**50**
Total Credits									**22**					**550**

Scheme A2: Semester 2nd

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A04	Plant Taxonomy & Economic Botany	261/BOT/CC204	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A05	Biochemistry & Bio techniques	261/BOT/CC205	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A06	Molecular Cytogenetics	261/BOT/CC206	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-02	Bioinformatics OR Advanced Plant Physiology	261/BOT/DS202	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-02	One from the Pool	261/BOT/MD202	02	00	02	02	00	01	03	15	35	05	20	**75**
Ability Enhancement Course(s)														
AEC-02	One from the Pool		02	00	00	02	00	00	02	00	50	00	00	**50**
Skill Enhancement Course(s)														
SEC-01	One from the Pool	261/BOT/SEC201	02	00	00	02	00	00	02	15	35	00	00	**50**
Total Credits									**22**					**550**

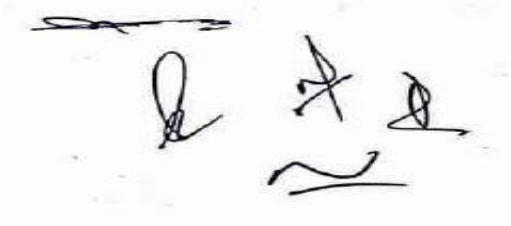
Note: *internship or field training or project of 4-6 weeks during summer vacation @ 4 credits.*



Scheme A2: Semester 3rd

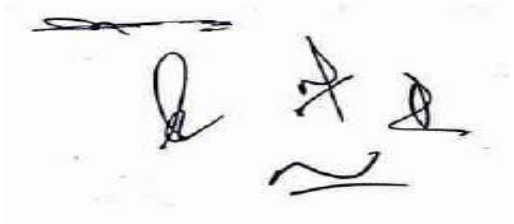
Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A07	Physiology of Plant growth	261/BOT/CC307	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A08	Biology of Reproduction and Anatomy	261/BOT/CC308	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A09	Bryophytes &Pteridophytes	261/BOT/CC309	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-03	Gymnosperms & Ethnobotany OR Advanced Phycology	261/BOT/DS303	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-03	One from the Pool	261/BOT/MD303	02	00	02	02	00	01	03	15	35	05	20	**75**
Skill Enhancement Course(s)														
SEC-02	One from the Pool	261/BOT/SEC302	02	00	00	02	00	00	02	15	35	00	00	**50**
Value added Course(s)														
VAC-02	One from the Pool	261/BOT/VA302	02	00	00	02	00	00	02	15	35	00	00	**50**
Seminars														
Seminar	Seminar	261/BOT/SEMINAR301	02	00	00	02	00	00	02	00	50	00	00	**50**
Internship/Field Activity#														
INTRSP	Industrial Visit/ Field Work and Report Writing	261/BOT/INTRSP301	02	00	00	02	00	00	02	00	50	00	00	**50**
Total Credits									**26**					**650**

 # Four credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.



Scheme A2: Semester 4th

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Ability Enhancement Course(s)														
AEC-03	Manuscript Writing**/ Pool	261/BOT/AE403	02	00	00	02	00	00	02	15	35	00	00	**50**
Dissertation/Project Work														
Dissertation	Industrial Training/Research Project/ Dissertation	261/BOT/DISSERTATION401	0	0	40	0	0	20	20	00	00	100	400	**500**
Total Credits									**22**					**550**



BOTANY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CCA01	261/BOT/CC101	**Algae & Fungi**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. The students will be inspired to become aware and comprehend the broader aspects of Algology.
2. The learning outcome will be aimed towards advanced academic education to broaden the knowledge its Biodiversity, Ecological significance and Economic importance of algae.
3. The students will be inspired to become well versed with the fungal world in terms of recent researches.
4. Economic importance of Fungi with regards to its deleterious and beneficial aspects. Modern economic importance of Lichens. Working knowledge of biological laboratories and research centers in India.

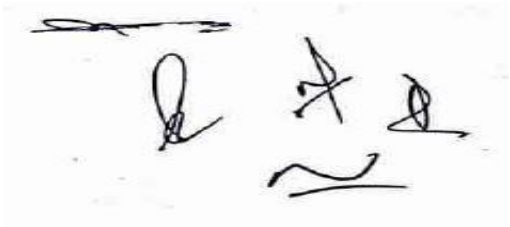
Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Criteria for algal classification (pigments, reserve food, flagella etc.) and their taxonomic importance. Comparative account of important systems of classification and recent trends. Thallus organization in algae and evolutionary trends. Economic importance of algae as food, feed, uses in industries etc. and algal biofertilizers.	12
II	Biodiversity of algae in different/ unusual habitats (terrestrial, freshwater and marine, thermal, psychrophilic, subaerial, symbiotic) Dynamics and consequences of algal blooms and red tides (Freshwater and Marine). Algae as major components of phytoplankton. Morphological features and life cycle patterns of major divisions with suitable examples (Cyanophyta, Chlorophyta, Xanthophyte, Bacillariophyta, Phaeophyta, and Rhodophyta).	11
III	General characters of fungi: Thallus organization, nutrition and reproduction. Classification of fungi by Ainsworth & Bisby (1983), Alexopoulus et. Al (1996). Phylogeny of fungi-characters used in classification. Different kinds of spores and their dispersal. Concept of Homothallism, Heterothallism, alternation of generations and parasexuality.	11
IV	General account of Myxomycota, mastigomycota, Zygomycota, Ascomycota, Basidiomycota and Mitosporic fungi. Economic importance of fungi in nutrient cycling, decomposition, humus formation, decay and deterioration of wood & timber. Application of Mycorrhizae in agriculture and forestry. Lichens: structure, reproduction and economic importance.	11
V Practical	1. Morphological study of representative members of Fungi: Synchytrium, Mucor, Taphrina, Puccinia, Ustilago, Agaricus, Alloymces, Phytophthora, Pilobolus, Saccharomyces, Fusarium 2. Morphological study of representative members of Algae : Vaucheria, Chara, Batrachospermum, Polysiphonia, Volvox, Cladophora, Oscillatoria, Anabaena, Spirulina, Scytonema, Rivularia, Haematococcus 3. Morphological study of representative of Algae: Chlorella , Hydrodictyon, Oedogonium , Ulva, Nitella, Botrydium, Ectocarpus, Dictyota , Laminaria, Fucus, Gelidium, Gracillaria	30

Learning Resources

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications.* Daya Publishing House, New Delhi. 2003.
2. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
3. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.
4. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publihers.
5. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.
6. Gupta, R.K. & Pandey, V.D. (2007): Advaces in Applied Phycology, Daya Publishing House, Daryaganj, New Delhi.
7. Hoek, C. Van Den, Mann, D.G. & Jahns, H.M. (1995): Algae: An Introduction to Phycology, Cambridge University Press, U.K.
8. Kaushik, B.D. (1987): Laboratory methods for Blue-green Algae, Associated Publishing Co., New Delhi.
9. Morris, I. (1980): The Physiological Ecology of Phytoplankton (studies in Ecology, Vol.7), Blackwell Scientific Publ., USA.
10. Prescott, L.M., Harley, J.P. & Klein, D.A. (1996): Microbiology, 3rd edition, Wm. C. Brown Publishers, USA.



BOTANY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC A02	261/BOT/CC102	**Molecular Biology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

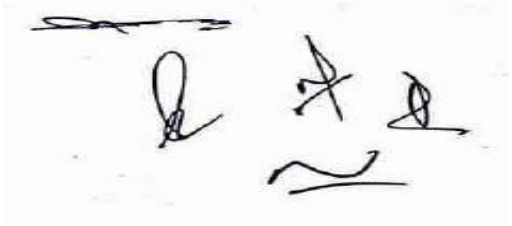
Course Learning Outcomes (CLO)

1. The youth will know DNA replication and DNA repair mechanisms
2. Students will come to know about the process of protein sorting and its mechanisms
3. Students will get the knowledge about the genes and the proteins associated with Cancer i.e. oncogenes and tumor suppressor proteins.
4. The students will gain the knowledge about molecular markers and its application.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

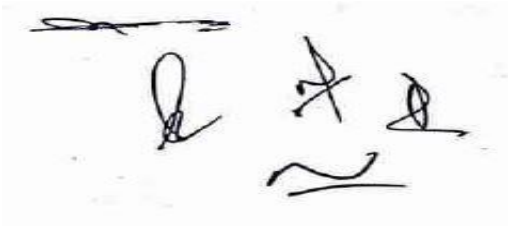
UNIT	TOPICS	CONTACT HOURS
I	DNA Replication: Mechanism of DNA replication in Prokaryotic and eukaryotic cells. Enzymes and accessory proteins involved in DNA replication and DNA repair. Transcription: Prokaryotic & Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5'- Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA & its stability.	12
II	Translation: Prokaryotic and eukaryotic translation, Regulation of translation, co- and post translational modifications of proteins. Protein Localization: Synthesis of secretory and membrane protein & their import into nucleus, mitochondria, and peroxisomes, Receptor mediated endocytosis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins	11
III	Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head & their desigining strategies, hairpin and other ribozymes. Applications of Antisense and ribozyme technologies. Homologous Recombination: Holliday junction, gene targeting, gene disruption, and' Cre/Lox recombination, RecA and other recombinases Molecular Mapping of Genome: Genetic and physical maps & their applications.	11
IV	Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers & their applications viz., forensic, disease prognosis, genetic counseling, Pedigree, animal trafficking and poaching; Germplasm maintenance, taxonomy and bio-diversity Genome Sequencing: Genomesizes, organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of Sequencing, sequence information for identification of defective genes.	11



V **Practical**	1. Isolation of Genomic DNA. 2. Isolation of RNA. 3. Quantitative analysis of DNA/RNA. 4. Restriction digestion of DNA. 5. Ligation of DNA fragments. 6. Molecular weight analysis using agarose gel electrophoresis. 7. Isolation of plasmid DNA. 8. Western blotting. 9. Southern blotting. 10. Preparation of competent cell.	30

Learning Resources

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitzand A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA. 3. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
3. Gene VI, Benjamin Lewin, Oxford University Press, U.K.
4. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers(Ed.), VCH Publishers, Inc., New York.
5. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis,
6. Cold Spring Harbor Laboratory Press, New York.
7. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York. 8. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford



BOTANY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC- A03	261/BOT/CC103	**Cell Biology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. This core course will make students able to understand how the cell functions as a unit of life.
2. Through this course, students will be able to appreciate the importance of various cell function and structures in the evolution of multicellular organisms.
3. The studies will make the students reveal elegance, dynamics and economy in the living cell and a gratifying unity in the principles by which a cell functions.
4. The students will know about the basic cellular and molecular approaches for cancer development and treatment.

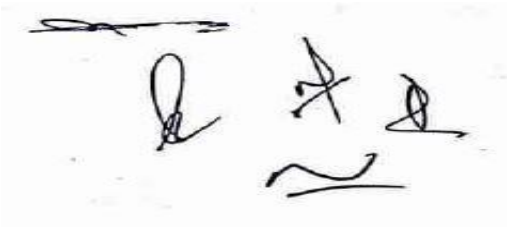
Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Biomembranes: Molecular composition and arrangement, functional consequences, membrane transportation; diffusion, active transport and pumps, uniports, symports and antiports,Donnan equilibrium;ion movements and cell function:, Maintenance of cellular pH; Receptor mediated endocytosis, The Extra Cellular Matrix Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata Ca^{++} dependent and Ca^{++} independent Homophilic cell-cell adhesion	12
II	Cytoskeleton and cell movement: Structure and organization of actin filaments, Actin, myosin and cellular movements, Structure and dynamic organizations of microtubules, Intermediate filaments, Cilia and flagella, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Protein sorting and transport, Protein uptake into the ER, Membrane proteins and Golgi sorting, Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway	11
III	Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, The events of M phase, Meiosis and fertilization, Genome organization, Chromosomal organization of genes and noncoding DNA, Mobile DNA, Pathways of intracellular signal transduction, Signaling networks	11
IV	Cell death and cell renewal: Apoptosis, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, Oncogenes, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing	11
V Practical	1. Preparation of mitotic and meiotic chromosomes. 2. Calculation of morphometric data and preparations of ideogram. 3. Preparation of karyotype from micrograph. 4. Study of permanent slides of meiosis 5. Study of permanent slides of mitosis. 6. Study of permanent slides of different types of cancer and their stages 7. Measurement of different types of cells by micrometry. 8. Study of cell membrane permeability using plant/animal cells. 9. Detection of cellular components using histochemical staining. 10. Study of permanent slides of different types of cancer and their stages.	30

Learning Resources

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific AmericanBook, Inc., USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
3. The Cell: A molecular approach by Geoffrey M. Cooper, Oxford university press
4. Essential cell Biology 5th edition, by Albert, Hopkin, Johnson, and Walter, WW Norton & Co
5. Karp's Cell & Molecular Biology, 9th Edition, by Gerald Carp, Janet Iwasa, Wallace Marshall, John willey & sons., 2020



BOTANY: SEMESTER-I

Course Code	Course ID	Course Title	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-101	261/BOT/DS101	**Bio-statistical methods and Data Analysis**	**2**	**2**	**15**	**35**	**50**	**3hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2hrs.**

Course Learning Outcomes (CLO)

1. This paper will help in understanding the students about a set of observations and then designing an experiment.
2. Students will be able to acquire, analyze and understand the significance of data.
3. Students will gain the knowledge about the hypothesis testing.
4. The paper will also help in understanding various Non-parametric tests.

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type type (14marks) covering the entire syllabus, will be compulsory. The remaining six questions will be set unit wise selecting two questions from each Unit I to III. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Data Analytics: Introduction, types, characteristics and advantages of data analytics. Descriptive statistical techniques: Central tendency, Dispersion, Skewness and Kurtosis. Correlation and Regression: Simple, Partial and Multiple.	10
II	Probability Theory: Concept and Approaches, Application of Additive and Multiplication Laws, Bay's Theorem, Mathematical Expectations. Probability Distribution: Binomial, Poisson, Normal.	10
III	Hypothesis Testing. Parametric tests: t-test and Analysis of Variance – one way classification, two-way classification. Chi-Square test & its application.	10
V Practical	1. Descriptive statistics: Systemic tabular summarization of data (before analysis), 2. To study measures of central tendency 3. To study measures of dispersion (using calculators). 4. Mean, Standard Deviation, proportion. 5. Chi-Square Test 6. T-test 7. Co-relation and Regression. 8. Analysis of Variance (One way and two ways).	30

Learning Resources

1. Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10th Edition, Wiley Series.
2. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2nd Edition,CRC Press
3. Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd.
4. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House
5. B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers,JPB



BOTANY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-101	261/BOT/DS101	**Genetic Engineering**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**05**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. The student should be able to design and comprehend experimental strategies for alteration of genes and gene products in variety of organisms.
2. CO2 Students could use various approaches to conduct genetic engineering and their applications in biological research as well as in biotechnology industries.
3. This paper deals with various scopes in genetic engineering along with molecular tools.
4. The students will gain the knowledge about the gene tagging and its role.

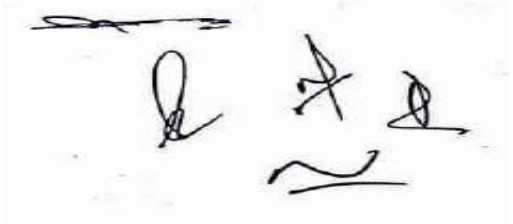
Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14marks) covering the entire syllabus, will be compulsory. The remaining six questions will be set unit wise selecting two questions from each Unit I to III. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Scope in Genetic Engineering. Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression. Cloning and patenting of life forms. Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers.	10
II	Nucleic Acid Purification, Yield Analysis, Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and cloning. Alternative Strategies of Gene Cloning. Transgenic and gene knockout technologies.	10
III	Microarray, Site-directed Mutagenesis and Protein Engineering. DNA transfection, Northern blot, Primer extension, Reporter assays. Recombinant proteins: Purification and folding, characterization and stabilization. Phage Display, T-DNA and Transposon Tagging. Gene tagging and its role	10
IV Practical	1. Bacterial culture and antibiotic selection Medias. 2. Preparation of competent cells. 3. Isolation of plasmid DNA. 4. Construction of restriction map of plasmid DNA. 5. Preparation of single stranded DNA template. 6. DNA sequencing 7. Gene expression in E. coli and analysis of gene product 8. PCR 9. Transformation of DNA in E.Coli.	30

Learning Resources

1. Gene cloning and DNA analysis – An Introduction (2006) 5th edition, T.A Brown, Blackwell publisher.
2. Essential genes (2006), Benzamin Lewin, Pearson education international.
3. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.
4. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.
5. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur.
6. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.
7. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science.
8. Molecular Biology of Gene (2008) 6th edition, Watson, Baker,Bell. Gann,Levine and Losick, Pearson education Inc.
9. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
10. Molecular Cloning : A Laboratory Manual (2000), J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York



BOTANY: SEMESTER-II

Course Code	Course ID	Course Title	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A04	261/BOT/CC204	**Plant Taxonomy and Economic Botany**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

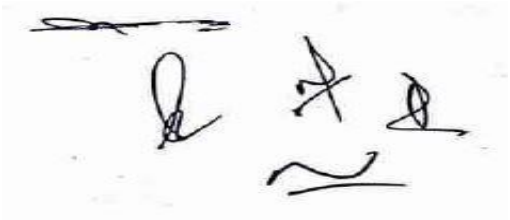
1. Understand the significance, basic concepts, tools of plant taxonomy
2. Learn about the different systems of classification of angiosperms and relevance of plant taxonomy to other branches.
3. Acquire knowledge about the plant sources of foods, modern and traditional medicines, spices, oil, fibers, dyes, gum and Timbers.

Instructions for Paper-Setter

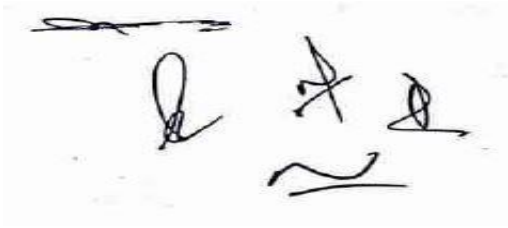
1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	The Species concept, Taxonomic hierarchy, Species, Genus and Family Taxonomic evidence: Morphology, anatomy, palynology. Taxonomic Tools: Herbarium and Floras. Botanical Gardens and herbaria in India; Botanical Survey of India its organization and role.	12
II	Salient Features of the International Code of Nomenclature (ICN). Systems of angiosperm classifications of Bentham and Hooker, Engler and Prantl, Hutchinson, Takhtajan, APG IV (2016) Relative merits and demerits of these systems.	11
III	Diagnostic features, systematic position and Economic importance of important plants of the following monocot families: Alismataceae, Poaceae, Cyperaceae, Arecaceae, Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Iridaceae and Orchidaceae.	11
IV	Diagnostic features, systematic position and Economic importance of important plants of the following dicot families: Nymphaeaceae, Magnoliaceae, Brassicaceae, Leguminosae (subfamilies), Malvaceae, Apiaceae, Lamiaceae, Solanaceae, Cucurbitaceae and Asteraceae.	11
V Practical	1. Systematic position, morphological study of representative members of Alismataceae, Poaceae, Cyperaceae, Arecaceae, Liliaceae, 2 Systematic position, morphological study of representative members of Musaceae, Zingiberaceae, Cannaceae, Iridaceae and Orchidaceae. 3. Systematic position, morphological study of representative members of Nymphaeaceae, Magnoliaceae, Brassicaceae, Leguminosae. 4. Systematic position, morphological study of representative members of Malvaceae, Apiaceae, Lamiaceae, Solanaceae, Cucurbitaceae and Asteraceae. 5. Economic importance of important plants of the monocot families 6. Economic importance of important plants of the dicot families.	30

Learning Resources



1. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row Publishers Inc.
2. Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan C., New York.
3. Davis, P.H. and Heywood, V.H. 1965. Principles of Angiosperm Taxonomy. D Van Nostrand Co. , New York.
4. Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford IBH Pub. Co., New Delhi.
5. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
6. Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
7. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
8. Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
9. SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd.,Delhi
10. Judd, W.S.; Campbell. C.S., Kellogg, E.A. and Stevens, P.F. 1999. Plant Systematics A Phylogenetic Approach. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, U.S.A.
11. Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA
12. Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.
13. Hancock. J. F. 2004. Plant evolution and the origin of crop species. 2nd edition. CABI Publishing, Cambridge, MA USA.
14. Radford, A. E., W. C. Dickison, J. R. Massey, C. R. Bell. 1976. Vascular Plant Systematics Harper and Row, New York..



BOTANY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A05	261/BOT/CC205	**Biochemistry & Biotechniques**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

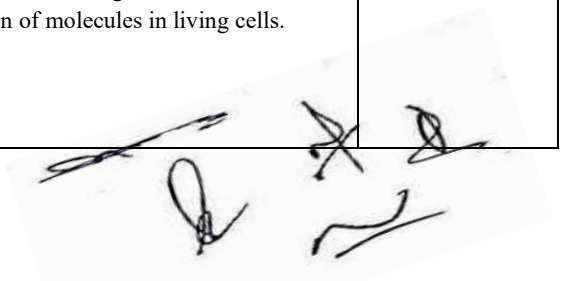
Course Learning Outcomes (CLO)

1. Students will be able to understand the general reactions of various metabolic pathways.
2. It will make the students to understand the structure and classification of biomolecules.
3. This paper will provide the basic understanding of various biological techniques.
4. The youth will be able to understand the basics of various techniques
5. It will make the students to understand the applications of these techniques for animal kindness.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

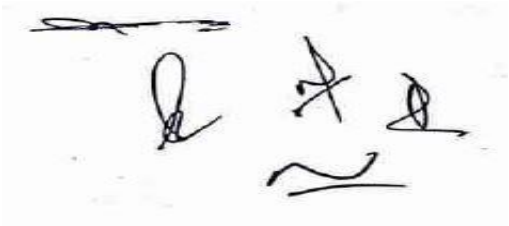
UNIT	TOPICS	CONTACT HOURS
I	General Introduction to Biomolecules, Amino acids and peptides-classification, chemical reactions and physical, properties Protein Biology: Primary, Secondary, tertiary and quaternary structure of proteins, Ramachandran plot and its significance Enzyme: Classification and nomenclature, Co-enzymes and Cofactors, Induced fit and Molecular Mechanism of Enzyme action, Enzyme feedback mechanism, Isozymes. .	12
II	Nucleic acids: Structure and Functions, DNA structure, types (A-, B-, Z-DNA) and functions, RNA structure, types (rRNA,tRNA,mRNA) and functions. Sugars - classification and reactions, metabolism of carbohydrates (glycolysis, TCA cycle, glycogenesis, glycogenolysis, gluconeogenesis, and the pentose phosphate pathway) and energetics, Oxidative phosphorylation Lipids- classification, structure and functions, Saturated and unsaturated fatty acid and their metabolism. Cholesterol biosynthesis, its metabolism	11
III	Microscopic techniques: Principle and applications of Light microscope; Phase contrast microscope; Fluorescence microscope; Electron microscope (EM) SEM, TEM. Centrifugation: Principles of sedimentation; Types, care and safety aspects of centrifuges; Differential centrifugation; Density gradient centrifugation and their applications. Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high-pressure liquid chromatography (HPLC) and FPLC.	11
IV	Electrophoresis: Principles and applications of agarose and polyacrylamide gel electrophoresis. Principles and uses of analytical instruments: Spectrophotometers, NMR spectrophotometer Immuno-techniques: Antibody generation; Detection of molecules using ELISA, RIA, Immunoprecipitation and Immunofluorescence microscopy; Detection of molecules in living cells.	11



V **Practical**	1. Titration of amino acids and determination of pKa values. 2. Determination of isoelectric point of an amino acid. 3. Isolation of proteins. 4. Quantitation of Proteins. 5. Benedict test for reducing sugar. 6. Demonstration of UV, Visible, and Fluorescence spectroscopy. 7. Demonstration of working of different types of microscopes. 8. Demonstration of Chromatography i.e. TLC/ HPLC/ GC. 9. To demonstrate the separation of proteins with the help of electrophoresis.	30

Learning Resources

1. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics.Agrobios, Jodhpur, India.
2. Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
3. Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, NewYork.
4. Hames, B.D.(Ed.).1998. Gel Electrophoresis of Proteins: A Practical Approach, 8th edition.PAS, Oxford University Press, Oxford, UK.
5. Scott, R.P.W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., NewYork.
6. Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition.Cambridge University Press, Cambridge, U
7. A Biologists guide to Principles and Techniques of Practical Biochemistry, K. Wilson and K.H.Goulding, ELBS Edn.
8. Lehninger AL, Nelson DL & Cox MM (1993) Principles of Biochemistry, 2nd edn. New York: Worth.
9. Stryer L (1995) Biochemistry, 4th edn. New York: WH Freeman.
10. Voet D, Voet JG & Pratt CW (1999) Fundamentals of Biochemistry. New York: Wiley.



BOTANY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A06	261/BOT/CC206	**Molecular Cytogenetics**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Students will be able to study the molecular composition of the chromosomes.
2. They will gain the knowledge about mutations and molecular basis of cell cycle and its check points
3. The paper deals with nature and mechanism of genomic imprinting.
4. Students will gain the knowledge about mutations and detection of mutagens.

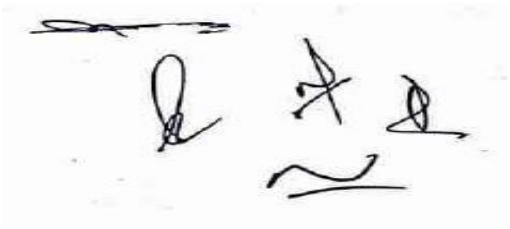
Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Biology of Chromosomes: Molecular anatomy of eukaryotic chromosomes; Metaphase chromosomes: Centromere, Kinetochore, Nucleolus organizers and rRNA genes, Telomere: structure and Functions, Heterochromatin and euchromatin, Giant Chromosomes: Polytene Chromosomes, Lamp brush Chromosomes	12
II	Sex Chromosomes: Sex determination and the Y Chromosome, Dosage compensation in *C. elegans*, *Drosophila* and Humans, Nature and mechanism of genomic imprinting, X- inactivation and imprinting, Sex specific imprinting	11
III	Genes in Pedigrees: Mendelian pedigree pattern, Inheritance of mitochondrial diseases, Complications to the basic pedigree patterns, non-Mendelian traits. Somatic Cell Genetics: Cell fusion and somatic cell hybrids – agents and mechanism of fusion, Heterokaryon – Cell lines and selection systems and chromosome segregation,	11
IV	Gene Mutations: Spontaneous mutations – Base pair substitution and frame shift mutations Induced mutations – Radiation, chemical and environmental, In –vitro site specific mutagenesis. Detection of mutagens – The Ames test and sister chromatid exchanges, Genetics of Cell Cycle: Genetic regulation of cell division in yeast and eukaryotes, Molecular basis of cellular check points.	11
V Practical	1. Study of chiasma frequency and terminalization co-efficient. 2. Study of mitosis from hepatic caeca of suitable insects/ onion root tip. 3. Preparation of karyotype 4. Preparation of ideogram. 5. Demonstration of banding techniques (C, G and T). 6. Study of induced polyploidy in sperm/pollen. 7. Making preparations from salivary glands of Chironomus larvae / Drosophila larvae to study polytene chromosomes. 8. Preparation of human buccal smear to study sex chromatin. 9. Identification of meiotic and mitotic stages from permanent slides.	30

Learning Resources

1. Atherly, A.C., J.R. Girton and J.F. McDonald. The Science of Genetics. Sauders CollegePublishing, Harcort Brace College Publishers, NY.
2. Brooker, R.J. Genetics : Analysis and Principles. Benjamin/Cummings, Longman Inc.
3. Fairbanks, D.J. and W.R. Anderson. Genetics – The Continuity of Life. Brook/ColePublishing Company ITP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley andSons. Inc., NY.
5. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. AnIntroduction to Genetic Analysis. W.H. Freeman and company, NY.
6. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo.
7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons. Inc., NY.
8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. MolecularBiology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo.
9. Tom Strachan & Read, A.P. Human Molecular Genetics 3rd edition, Garland Publishing2004, London.



BOTANY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-02	261/BOT/DS202	**Bioinformatics**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

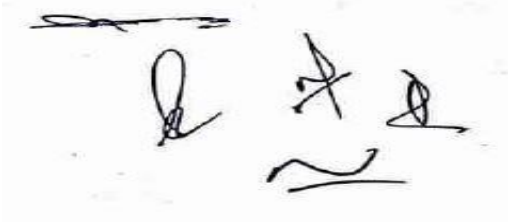
Course Learning Outcomes (CLO)

1. Students will develop proficiency in using programming languages.
2. They will learn to analyze and interpret genomic and proteomic data
3. Students will deepen their knowledge of fundamental concepts in molecular biology and genetics.

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14marks) covering the entire syllabus, will be compulsory. The remaining six questions will be set unit wise selecting two questions from each Unit I to III. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Computers: An overview of computers, microcomputers, VDUs and printer; What is programming Algorithms; Languages and packages: Introduction to MS Office, MS Access, introduction to SQL (structured query language) Handling arrays, procedures. Introduction to PERL: Applications of PERL in Bioinformatics: Storing DNA sequence, DNA to RNA transcription, finding motifs, counting nucleotides, generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA.	10
II	Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Preliminary ideas of query and analysis of sequence information. Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, Needleman, Wusch&amp, SmithWaterman algorithms.	10
III	Database Search Algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results. Pattern Recognition Methods in Sequence Analysis: Concept of a sequence pattern, regular expression-based patterns. The use of pattern databases like PROSITE and PRINTS. Theory of profiles and their use with special reference to PSIBLAst. Markov chains and Markov models and their use in gene finding.	10
Practical (V)	1. Retrieve Nucleotide sequences from NCBI serve. 2. Retrieve Protein sequences from PDB. 3. Analysis of sequences Similarity using BLAST/pBLAST/nrBLAST 4. To predict protein secondary structures by using iPred. 5. Perform phylogenetic analysis using PHYLIP. 6. Perform multiple sequence alignment by using ClustalW. 7. Primer design	30

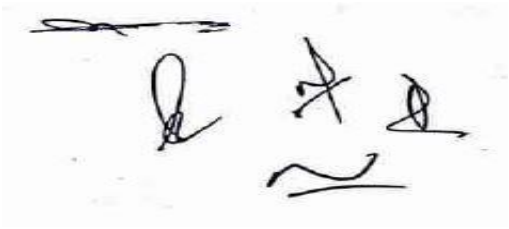


Learning Resources

1. Jin Xiong (2006) Essential Bioinformatics. Cambridge publisher
2. ZhumurGhosh and BibekanandMallick (2008) Bionformatics: Principles andApplications. Oxford University Press publisher
3. OrpitaBosu and SimminderKaurThukral(2007). Bioinformatics. Oxford University Presspublisher
4. M.Lesk (2002) Introduction to Bioinformatics. Oxford University Press publisher
5. Fundamental Concepts of Bioinformatics, Dan E. Krane, Michael L. Raymer, Michaeel

L. Raymer, Elaine NicponMarieb, 2002, Benjamin/Cummings

6. P. Rastogi and N. Mendiritta (2013) Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt.Ltd; 4th Revisededition
7. Mount and David W (2004) Bioinformatics: sequence and genome analysis. Cshl Press,2nd edition
8. Harisha S (2007) Fundamentals of Bioinformatics. I K International Publishing HousePvt. Ltd
9. Dan E. Krane (2003) Fundamentals concepts of bioinformatics. Dorling Kindersley (RS);First edition
10. David Edwards and Jason Stajich (2009) Bioinformatics: Tools and Applications.Published by Springer



BOTANY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-02	261/BOT/DS202	**Advanced Plant Physiology**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. The students will be able to understand the physiological and biochemical basis of drought stress and its manifestation in plant productivity.
2. The students will be well acquainted with the mechanisms of salt and temperature stresses.
3. The learners will acquire the in-depth knowledge of process of photosynthesis and the translocations of photosynthates from source to sinks.
4. The students will enhance their knowledge regarding mechanism of respiratory cycle in plants and the methods of estimation of respiration.

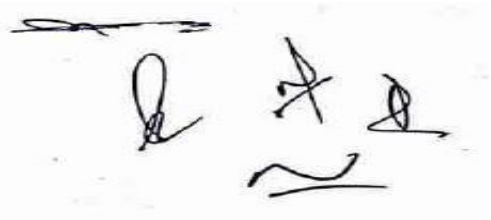
Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14marks) covering the entire syllabus, will be compulsory. The remaining six questions will be set unit wise selecting two questions from each Unit I to III. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Water stress: Drought, its definition and quantification, water deficit and plant growth, physiological and biochemical functions, responses injury affected by drought, Adaptive strategies for drought resistance. Osmotic adjustment, Osmo-protectants. Water logging/ oxygen deficiency and its effects on plant growth.	10
II	Salt and temperature stress: Salt stress; Saline and alkaline soils, salt stress injury, mechanism of salt stress and halophytes. Temperature stress; high temperature stress, heat shock proteins, chilling and frost injury and mechanism of tolerance.	10
III	Photosynthesis: The four major complexes of thylakoids. The path of carbon in photosynthesis (C3, C4 and CAM plants) Rubisco, structure and its association with the mechanism of carboxylation and oxygenation of RUBP. Effect of environmental factors on photosynthetic rates. Respiration: Glycolic acid metabolism and photorespiration. Glyoxylate cycle.	10
V Practical	1. Demonstration of stomatal activity from suitable plant material. 2. To study the effect of salt stress on seed germination and plant growth in terms of metabolites. 3. To study the effect of water stress on seed germination and plant growth in terms of metabolites. 4. To separate and identify chloroplast pigments using Paper chromatography. 5. To study the effect different light intensities on the rate of photosynthesis. 6. Set up Wilmott's bubbler and study the effect of varying CO_2 concentration	30

Learning Resources

1. Bonner, J. And Varner, J.E. (1976) Plant Biochemistry, Academic Press, New York and London (Third Edition).
2. Buchanan, B.B., Gruissem, w. And Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
3. Cooper, T.G. (1977). Electrophoresis. In : The Tools of Biochemistry. John Wiley and Sons., New York.
4. Dey, P.M. and Harborne, J.B. (1997), First Indian edition, 2000). Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.
5. Noggle, G.r. and Fritz, G.J. (1983). Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition (Seventh reprint, 1992).
6. Salisbury, F.B. and Ross, G.W. (1992). Plant Physiology. Fourth Edition, Wadsworth Publishing Co. Belmont, California, USA.
7. Sawhney, S.K. and Singh, Randhir. (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
8. Solmos, T. (1977). Cyanide resistant respiration in higher plants. In : Ann. Rev. Pl. Physiol. 28: 279-297.



Scheme A2: Semester 3rd

BOTANY: SEMESTER-III								
Course Type	**Course Code**	**Name of theCourse**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A07 4 credits	**261/BOT/CC307**	**Physiology of plant growth & development**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

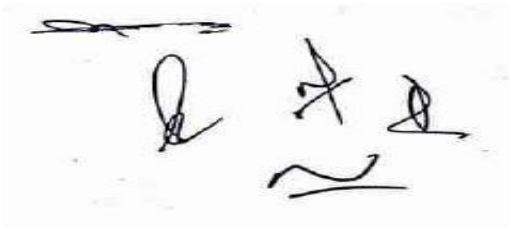
Course Learning Outcomes (CLO)

1. The students will be able to understand the basic concepts of plant growth and development.
2. The students will be learning about abiotic stress tolerance/adaptive physiological changes affecting plant productivity.
3. During the course students will gain in depth knowledge about various plant growth regulators and their role in physiology of growth and development.
4. Students will be acquainted with the knowledge of physiology of flowering and sensory biology.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

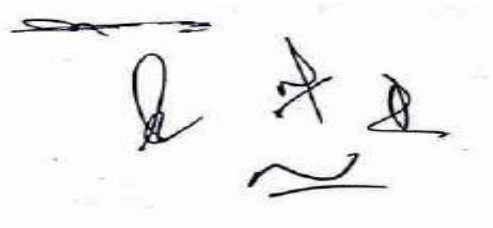
UNIT	TOPICS	CONTACT HOURS
I	Plant Growth: Growth concepts, Growth curves, Growth analysis. Germination and Dormancy of seeds; factors affecting dormancy and its regulation by plant growth regulators and environmental factors. Stress Physiology: Response of plants to abiotic stresses: abiotic stress affecting plant productivity. Basic principles of crop improvement programme under stress.	12
II	Plant Growth Regulators: Discovery, biosynthetic pathways and transport of Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid. Mechanism of action of: Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid. Influence on plant growth regulators on plant growth: Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid.	11
III	Senescence and Abscission, Physiological and biochemical changes associated with senescence and abscission. Tropism: Phototropism, nature of receptors, role of hormones, Geotropism and nastism.	11
IV	Sensory Photobiology: Phytochromes: mechanism of phytochrome action, photomorphogenesis and cryptochromes. The Flowering Process: Photoperiodism and its significance, importance of dark periods, role of vernalization. Nature and events during flowering, florigen concept, chemical control of flowering.	11



V **Practical**	1. Determine the osmotic pressure (potential) and calculate the isotonic coefficient of sugar. 2. Determine the diffusion pressure deficit of plant cells 3. Study the structure of stomata and find out their frequency on the adaxial and abaxial surfaces of leaves 4. Separate pigments, viz., chlorophyll 'a' and 'b', carotene and xanthophylls from green leaves by paper chromatography and column chromatography 5. Effect of plant hormones on growth. 6. To study plant responses to red and far-red light.	30

Learning Resources

1. Audus, L.J. (1972). Plant Growth Substances. Vol.I Chemistry and Physiology. Leonard Hill, London.
2. Bonner, J. And Varner, J.E. (1976). Plant Biochemistry,IIIrd Edition, Academic Press, New York and London.
3. Buchanan, B.B., Gruissem, W. And Jones, R.L. (2000). Biochemstry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
4. Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.
5. Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt.Ltd.
6. Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.
7. Hopkins, W.G. 1995 Introduction to Plant Physiology, John Wiley and Sons.
8. Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
9. Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East- West Press Pvt Ltd. New Delhi.



BOTANY:
SEMESTER-III

Course Type	Course Code	Name of theCourse	Credit	Contact Hours/ Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A08 4 credits	**261/BOT/CC308**	**Biology of reproduction and anatomy**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. The students will be able to understand the structure and development of reproductive structures and the process of reproduction in angiosperms.
2. Acquire knowledge about in vitro culturing techniques and their applications in human welfare.
3. Learn about the role of anatomy in taxonomy and anomalous secondary structures in plants.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	History of plant embryology Male gametophyte: structure of anther, microsporogenesis, role of tapetum, Pollen development, male sterility; Pollen germination, pollen tube growth and guidance; pollen allergy	11
II	Female gametophyte; ovule development, megasporogenesis; Organization of the embryo sac, structure of the embryo sac cells. Pollination, Pollination mechanisms and vectors,	11
III	Pollen pistil interaction and fertilization; structure of pistils; pollen-stigma interaction, sporophytic and gametophytic incompatibility, double fertilization Endosperm development, polyembryony; apomixis Experimental Embryology: in vitro fertilization Anther, Pollen and embryo culture,	11
IV	Anatomy in relation to taxonomy. Anomalous secondary Structure: Anomalous secondary growth, anomalous position of cambium, abnormal behaviour of normal cambium, accessory cambium formation and its activity, extrastelar cambium, Interxylary and intraxylary phloe, presence of medullary bundles, cortical bundles, presence of exclusive phloem and xylem bundles, secondary growth in monocots.	12
V Practical	1. Study of meristems through permanent slides and photographs. 2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs) 3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides). 4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides). 5. Leaf: Dicot and Monocot leaf (only Permanent slides). 6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem). 7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). 8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.	30

Learning Resources

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.

2. Shivanna, K.R. and Johri, B.M. 1985. The Angiopsrem Pollen: Structure and Function. Wiley Eastern Ltd., New Delhi.

3. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge Univ. Press, Cambridge. Johri, B.M. (ed.) Embryology of Angiosperms. Springer-Verlag, Heidelberg, Berlin, Esau, K. 1965. Plant Anatomy. John Wiley & Sons

4. Fahn, A. 1967.Plant Anatomy. Pergamon Press, London, New York.

5. Eames, A.J. and MacDaniels, L.H. 1947. An Introduction to the Plant Anatomy (2nd Ed.), McGraw Book Comp., New York.

6. Eames, A. J. 1961. Morphology of Angiosperms. McGraw Hill Book Company, New York

BOTANY: SEMESTER-III								
Course Type	**Course Code**	**Name of theCourse**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A09 4 credits	**261/BOT/CC309**	**Bryophytes & Pteridophytes**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Identify and classify the major groups of non-flowering plants: Bryophytes and Pteridophytes, based on morphological and reproductive features.
2. Describe the life cycles of Bryophytes and Pteridophytes, emphasizing alternation of generations and the dominance of gametophyte or sporophyte stages.
3. Explain the evolutionary trends and adaptations that distinguish these groups and contribute to their success in terrestrial environments.
4. Compare and contrast the structural complexity, vascular systems, and reproductive strategies among Bryophytes and Pteridophytes.

Instructions for Paper-Setter

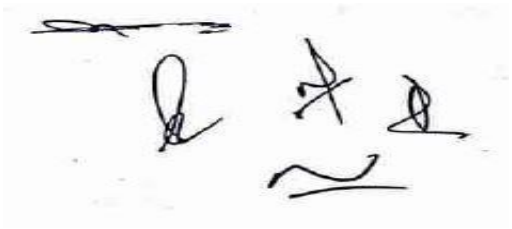
1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Bryophytes: Systems of classification, distribution, Economic importance. Habitat, external and internal morphology, reproduction,	11
II	Gametophytes and sporophytes in Bryophytes, phylogeny and interrelationships of the orders: Sphaerocarpales, Takakiales, Marchantiales and Jungermanniales, Anthocerotales, Sphagnales, Andreales and Bryales.	11
III	Pteridophyta: Classification, Origin and evolution, Phylogenetic relationship with Bryophyta. Morphology, anatomy, phylogeny and interrelationships of the orders Psilopsida-Psilotales and Psilophytales, Lycopsida- Lycopodiales, Selaginellales, Isoetales, Equisetopsida – Equisetales and Pteropsida- Filicales.	11
IV	Sporophyte and gametophyte in Pteridophytes, Stelar organization and evolution, Origin of leaf and Telome concept, Sporocarp, Heterospory and seed habit, Comparison of Pteridophyta with Bryophyt	12
V Practical	1. **Vegetative Organization**: Marchantia, Riccia, Anthoceros, Sphagnum, Polytrichum. 2. **Anatomical Organization**: Marchantia, Cyathodium, Anthoceros, Sphagnum. 3. **Archegonia and Antheridia and their Organization**: Riccia, Marchantia, Anthoceros, Sphagnum. 4. **Sporophytes**: Riccia, Marchantia, Pellia, Anthoceros, Funaria, Sphagnum, Polytrichum. 5. **Pteridophytes**: Morphological and anatomical studies of 1) Psilotum 2) Lycopodium 3) Selaginella, 4) Isoetis, 5) Equisetum,6) Ophioglossum, 7) Osmunda, 8) Gleichenia, 9) Pteris, 10) Adianium,11) Marselia, 12) Salvinia, 13) Azollaand additional forms/species collected during study tour. 6. **Study of permanent slides**.	30

Learning Resources

1. Bir, S. S. (2005) Pteridophytes their Morphology, Cytology, Taxonomy and Phylogeny. Today & Tomorrow's Printers and Publisher.
2. Biswas, C. and B. M. Johri (2004) The Gymnosperms, Narosa Publishing House, New Delhi
3. Campbell, C. J. (1940) Evolution of land Plants, Stanford University Press.
4. Coulter J. M. and C. J. Chamberlain (1978) Morphology of Gymnosperms, Central Book Depot, Allahaba
5. Eames, A. J. (1974) Morphology of Vascular Plants- lower groups, Tata Me Graw-Hill Publishing Co. New Delhi.

6. Foster, A. S. & F. M. Gifford (1967) Comparative morphology of vascular plants, Freeman Publishers, San Fransisco.
7. Kakkar, R. K. and B. R. Kakkar (1995) The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad.
8. Kashyap S. R. (1932) Liverworts of Western Himalayas and the Plains.Vol. I & II, The University of Panjab, Lahore.
9. Parihar, N. S. (1991) Bryophytes, Central Book Dept., Allahabad. Parihar, N. S. (1976) The biology and morphology of the pteridophyta, Central Book Depot, Allahabad.
10. PuriPrem (2005) Bryophytes Morphology, Growth and Differentiation- Pulisher- Atmaram and Sons New Delhi
11. Rashid, A. (1976) An introduction to pteridophyta, Vikas Publishing House Ltd., New Delhi.
12. SambamurtyA. V. S. S, (2005) A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, Today & Tomorrow's Printers and Publishers
13. Sharma O. P. (2002) Gymnosperms, PragatiPrakashan, Meerut.
14. Sharma P. N. and Sahni K. C. (2005) Gymnosperms of India and Adjacent Countries PublisherBhishan Singh Mahendra Pal Singh, Dehradun
15. Tewari, Shiv Datt and GiriBala Pant (2005) Bryophytes of Kumaun Himalaya. Publisher-Bhishan Singh Mahendra Pal Singh-Dehradun
16. Siddiqui K. A. (2002) Elements of Paleobotany, KitabMahal, Allahabad.
17. Smith, G. M. (1976) Cryptogamic Botany - Vol. II, Tata Me Graw-Hill Publishing Co. Ltd. New Delhi.
18. Sporne, K. R. (1976) Morphology of Pteridophyta. Hutchinson University Library, London.



BOTANY: SEMESTER-III

Course Type	Course Code	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-03 3 credits	**261/BOT/DS303**	**Gymnosperms & Ethnobotany**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Classify and distinguish gymnosperms from other groups of plants.
2. Trace evolutionary trends in development of male and female gametophytes.
3. Learn about economic importance of gymnosperms and modern methods of their propagation.
4. Explain the ethnobotany, its history, significance, methods and techniques used in ethnobotanical study and research.

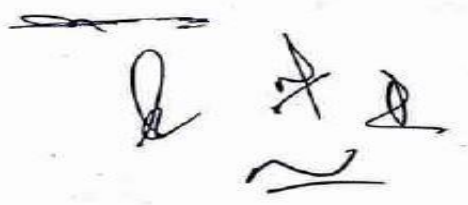
Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14marks) covering the entire syllabus, will be compulsory. The remaining six questions will be set unit wise selecting two questions from each Unit I to III. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Gymnosperms: Introduction, Classification and distribution of Gymnosperms. Brief account of the following families: Lyginopteridaceae, Medullosaceae, Glossopteridaceae, Caytoniaceae.	10
II	General account of the following orders: Cycadeoidales (Cycadeoidea), Pentoxylales, Cordiatales, Cycadales (Cycas), Ginkgoales (Ginkgo). Morpho-anatomical features and reproduction in the following: Coniferales (Pinus, Cedrus), Ephedrales (Ephedra), Welwitschiales, Gnetales. Economic importance of gymnosperms	10
III	Ethnobotany: History, concept, scope and importance of ethnobotany, sub-disciplines of ethnobotany (ethnomedicobotany, ethnozoology, ethnoveterinary, ethnomusicology and ethnoagriculture), methods of research in ethnobotany. Systems of indigenous medicine (Ayurveda, Siddha, Unani, Homeopathy, Yoga and Naturopathy), major disciplines of ayurveda, use of herbal medicines by tribals.	10
V Practical	**1. Gymnosperms**: Study of the vegetative and reproductive parts, including anatomy (**using permanent slides**) of the following genera: Cycas, Zamia, Pinus, Cedrus, Taxodium, Cryptomeria, Cupressus, Thuja, Juniperus, Podocarpus, Cephalotaxus, Agathis, Araucaria, Taxus, Ginkgo, Gnetum. **2 Ethnobotany:** Collect plant samples, dry them, and identify them using botanical keys. **3** Conduct interviews with local people to gather information about their traditional knowledge of plant use, including medicinal, food, and other applications. **4** Record the specific parts of the plant used (e.g., leaves, roots, bark), preparation methods, and the traditional uses of each plant. **5** Conduct case studies to explore the ethnobotanical uses of specific gymnosperm species in different regions.	30

Learning Resources

1. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New Delhi.
2. Sporne, K.R. 1965. The Morphology of Gymnosperms. B.I. Publications Pvt. Ltd., New Delhi.
3. Bierhorst, D. W. 1971. Morphology of Vascular Plants. Macmillan. New York.
4. Cotton, C.M. 1996. Ethnobotany- Principles and Appliations, Centruy School Book by service Film setting Ltd.
5. Dahlgren. R.H., Clifford, T and P.F Yeo 1985.The families of the monocotyledons; structure, Evolution and Taxonomy. SpingeVerag, NY.
6. Gary J, Martin, 2004. Ethnobotany- A Methods Manual, Chapman and Hall. U.K.
7. Jain S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.
8. Jain S.K. 1987. A manual of ethnobotany. Scientific publisher Jodhpur.
9. Jain S.K. and Mundgal, 1999. Handbook of ethnobotany, London.



BOTANY: SEMESTER-III

Course Type	Course Code	Name of the Course	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-03 3 credits	261/BOT/DS303	Advanced Phycology	2	2	15	35	50	3 hrs.
		Practical	1	2	5	20	25	2 hrs.

Course Learning Outcomes (CLO)

1. To acquaint the PG students with importance of Phycology (Algology) towards its contribution to the famous 'Green Revolution' of the nation, thereby making India self-reliant in food grain production.
2. To come out with the trained professionals having the knowledge of nutritional requirements of algae for their mass/ large scale cultivation with particular reference to ecological biodiversity of algae & algal bio-fertilizers in Haryana.
3. The Course has been conceived to equip the students with the knowledge of various laboratory conditions for their culture and maintenance of algae in terms of their control in water supplies, on ancient monuments and Paddy field algal flora as the N_2-economy builders of the nation.
4. The Course has been conceived to equip the students with the knowledge of various physiological and biochemical aspects on algal flora exposed to pesticides, toxicants and heavy metals to comprehend the mechanisms of adaptation against them in terms of their uptake kinetics.

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14marks) covering the entire syllabus, will be compulsory. The remaining six questions will be set unit wise selecting two questions from each Unit I to III. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	A brief account of phycological researches in India. Synchronous & continuous cultures and their uses; Physiology of nutrient regulated algal growth. A brief account of culture techniques, media for algal growth and measurement techniques	10
II	Algae in water supplies, on ancient monuments and bio-fouling of ships. Ecological biodiversity of algae in unusual habitats with suitable examples. Paddy field algal flora as N_2-economy builders of the nation.	10
III	Physiological and biochemical aspects on algal flora exposed to heavy metals. Kinetics of heavy metal uptake and its bioaccumulation. Mechanisms of adaptation against tolerance to toxicants, pesticides and salt.	10
V Practical	1. To illustrate various methods prescribed for algal culture. 2. To culture any one alga (Spirulina/Chlorella/Scenedesmus/Botrycoccus/ Dunaliella) in laboratory. 3. To estimate the algal proteins of the cultured alga. 4. Biochemical analysis of the cultured alga for food /bio-fuel properties.	30

Learning Resources

1. Ahluwalia, A.S. (Ed.). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. 2003.
2. Becker, E.W. (1994): Microalgae – Biotechnology & Microbiology, Cambridge University Press, Cambridge, U.K.
3. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
4. Dubey, R.C. (2006): Introduction to Biotechnology, Delhi Book Trust, New Delhi.
5. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.
6. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publishers.
7. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.

BOTANY:
SEMESTER-IV

Course Type	Course Code	Name of the Course	Credit	Contact Hours/ Week	Internal Assessment marks	End Term Marks	Max. Marks
Dissertation	261/BOT/DISSERTATION401	**Dissertation**	**20**	**40**	**100**	**400**	**500**

Course Learning Outcomes (CLO)

1. **Demonstrate advanced knowledge and understanding** of a specialized area within the field of botany, integrating current research and scientific literature.
2. **Formulate a clear research question or hypothesis** and design a methodologically sound investigation to address it.
3. **Apply appropriate experimental, analytical, or field techniques** to collect, analyse, and interpret botanical data.
4. **Critically evaluate scientific data** and discuss its implications in the context of existing botanical theories and research.
5. **Present research findings clearly and effectively** in a well-structured scientific dissertation, adhering to academic standards of writing and referencing.
6. **Defend research outcomes** and methodology in an oral or written format, demonstrating a thorough understanding of the research topic and its broader scientific context.
7. **Work independently and manage time effectively** over an extended research project, showing initiative, problem-solving ability, and scientific integrity.

COURSE DESCRIPTION:

***Industrial Training/Research Project/ Dissertation*:** Every student will be required to undertakeIndustrial Training or a research project based on related areas of Botany. The training/research project report will be submitted in the form of dissertation and will be presented forevaluation at the end of semester by an external expert. The internal and external assessment of training and project work will be carried out as following.

Internal Assessment:

- Synopsis
- One Mid-semester progress report/presentation

External Assessment:

- Final project report and viva-voce presentation.

Dissertation Report Submission Guidelines:

The dissertation report should be contained followings:

1. Dissertation report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.
   - The paper size to be used should be A-4 size.
   - The font size should be 12 with Times New Roman.
   - The text of the dissertation may be typed in 1.5 (one and a half) space.
   - The print out of the dissertation shall be done on both sides of the paper (instead of singleside printing)
   - The total no. of written pages in dissertation report should be 40 to 60.
2. The candidate shall be required to submit three hard bound copies of dissertation along with aCD in the department as per the date announced.
3. Plagiarism should be below 20% (with filter of 5 words in a line from the same source) andstudents are required to produce letter of undertaking regarding plagiarism.
4. The candidate will defend her/his dissertation/project work through presentation before theExternal examiner at the end of semester and will be awarded marks.

