FACULTY OF SCIENCES

SYLLABUS FOR THE BATCH
FROM THE YEAR 2022 TO YEAR 2025

Programme Code: MBOT

Programme Name: M.Sc. Botany

(Semester I-IV)

Examinations: 2022-2025

DEPARTMENT OF BOTANY
KHALSA COLLEGE, AMRITSAR

(An Autonomous College)

Note: (a) Copy rights are reserved. Nobody is allowed to print it in any form.
(b) Subject to change in the syllabi at any time.
(c) Please visit the University website time to time

S.No.	PROGRAMME OBJECTIVES
1.	M.Sc. Botany imparts advanced knowledge on modern biology to the students. The curriculum of the programme fosters problem-solving and critical thinking skills and prepares students to take on any challenges.
2.	The students will gain insights into the key research areas of botany. The programme encompasses a balance of both theoretical and practical sessions which enables the students to apply their learning and develop end results.
3.	The programme focuses on career-oriented subjects like Microbial Biotechnology, Plant tissue culture, Enzymology, Genetics, Plant breeding, Mathematiocal biology, Plant physiology, Biochemistry, Anatomy and Molecular biology.
4.	The progamme develop a thirst amongst the students to preserve the natural resources and environment.
5.	The programme enables the students to prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.
6.	M.Sc. Botany is a two-year postgraduate programme to impart advanced knowledge on modern biology. Other than providing students with indispensable knowledge, the programme curriculum fosters problem-solving and critical thinking skills that prepare students to take on any challenges.

S.No.	PROGRAMME SPECIFIC OUTCOMES (PSOS)
PSO-1	Formulate the ideas, draft scientific reports, authenticate conclusions, present effectively with effective communication skills.
PSO-2	Integrate knowledge of fundamental aspects of Botany with applied aspects to design the experiment, interpret the data, and provide valid conclusions.
PSO-3	Understand the relationship between science and society by recognizing and discussing logical, scientific and ethical issues in Botany subject.
PSO-4	The student completing the course is capable of executing research projects/dissertations using tools and techniques in any of the basic specializations of Botany under supervision.
PSO-5	Documentation and report writing on experimental protocols, results and conclusions, study tours and field visits etc.

M.Sc. Botany
Programme: MBOT
Scheme of Courses
Session 2022-2025

Course Scheme						
Semester -I						
Course Code	**Course Name**	**Hours /Week**	**Max. Marks**			**Page No.**
			Theory/ practical	**Int. Ass.**	**Total**	
BOTC511	Phycology	3	37	13	50	6-7
BOTC512	Mycology and Plant Pathology	3	37	13	50	8-10
BOTC513	Genetics and Evolution	3	37	13	50	11-13
BOTC514	Plant Physiology	3	37	13	50	14-16
BOTC515	Introduction to Computers and Basic Bioinformatics	3	37	13	50	17-19
BOTC516	Theoretical Biology	3	37	13	50	20-21
BOTC551	Botany Practical I (Based on BOTC511, BOTC512 & BOTC513)	6.5	56	19	75	7, 10, 13
BOTC552	Botany Practical II (Based on BOTC514, BOTC515 & BOTC516)	6.5	56	19	75	16, 19, 21
Total		**31**	**450**			

Int. Ass. = Internal Assessment

M. Sc. Botany
Programme: MBOT
Scheme of Courses
Session 2022-2025

COURSE SCHEME						
SEMESTER - II						
Course Code	**Course Name**	**Hours /Week**	**Marks**			**Page No.**
			Theory/ practical	**Int. Ass.**	**Total**	
BOTC521	Bryology	3	37	13	50	22-23
BOTC522	Diversity and Biology of Gymnosperms	3	37	13	50	24-25
BOTC523	General Microbiology	3	37	13	50	26-28
BOTC524	Cell Biology	3	37	13	50	29-31
BOTC525	Pteridology	3	37	13	50	32-33
BOTC526	Ecological Modelling and Forest Ecology	3	37	13	50	34-36
BOTC561	Botany Practical I (Based on BOTC521, BOTC522 & BOTC523)	6.5	56	19	75	23, 25,28
BOTC562	Botany Practical II (Based on BOTC524, BOTC525 & BOTC526)	6.5	56	19	75	31, 33,36
BOTC563	On Job Training or Assignment	2	Satisfactory/ Not Satisfactory			
Total		**33**	**450**			
In addition to the courses listed above, a candidate may be required to study additional optional course/s in Botany or other disciplines, as may be approved by the Board of Control. The marks obtained in such papers will be entered in the transcript but will not add to total marks obtained by the candidate for the award of the degree.						

Int. Ass. = Internal Assesement

M.Sc. Botany
Programme: MBOT
Scheme of Courses
Session 2022-2025

COURSE SCHEME						
SEMESTER - III						
Course Code	**Course Name**	**Hours/Week**	**Marks**			**Page No.**
			Theory/ practical	**Int. Ass.**	**Total**	
BOTC611	Plant Morphogenesis	3	37	13	50	37-39
BOTC612	Developmental Botany	3	37	13	50	40-42
BOTC613	Plant Molecular Biology	3	37	13	50	43-44
BOTC614	Plant Breeding and IPR	3	37	13	50	45-47
BOTC615	Plant Biochemistry	3	37	13	50	48-50
BOTC616	Applied Botany	3	37	13	50	51-53
BOTC651	Botany Practical I (Based on BOT C611, BOT C612 & BOT C613)	6.5	37	13	50	39, 42, 44
BOTC652	Botany Practical II (Based on BOT C614, BOT C615 & BOT C616)	6.5	56	19	75	47, 50, 52
BOTC653	Field Study	Satisfactory/ Not Satisfactory				
BOTC654	Seminar	2	20	5	25	
Total		**33**	**450**			
@ In addition to the courses listed above, a candidate may be required to study additional optional course/s in Botany or other disciplines, as may be approved by the Board of Control. The marks obtained in such papers will be entered in the transcript but will not add to total marks obtained by the candidate for the award of the degree.						

Int. Ass. = Internal Assessment

M.Sc. Botany
Programme: MBOT
Scheme of Courses
Session 2022-2025

COURSE SCHEME						
SEMESTER IV						
Course Code	**Course Name**	**Hours/Week**	**Marks**			**Page No.**
			Theory/ practical	**Int. Ass.**	**Total**	
BOTC621	Plant Anatomy	3	37	13	50	54-56
BOTC622	Structure and Metabolism of Plant Hormones	3	37	13	50	57-59
BOTC623	Plant Tissue Culture and Biotechnology	3	37	13	50	60-62
BOTC624	Analytical Techniques	3	37	13	50	63-64
BOTC625	Diversity and Biology of Angiosperms	3	37	13	50	65-67
BOTC724	Hazardous Chemicals *	3	37	13	50	68-69
BOTC661	Botany Practical I (Based on BOT C621, BOT C622 &BOT C623)	6.5	56	19	75	56, 59, 62
BOTC662	Botany Practical II (Based on BOT C624 & BOT C625)	4.5	56	19	75	64, 67
BOTC663	Assignment	1	Satisfactory/ Not satisfactory			
BOTC664	Research Techniques	3	Satisfactory/ Not satisfactory			
Total		**33**			**450**	

* List of Optional Papers
1. BOT C724 - Hazardous Chemicals
2. BOT C725 – Immunology

@ In addition to the courses listed above, a candidate may be required to study additional optional course/s in Botany or other disciplines, as may be approved by the Board of Control. The marks obtained in such papers will be entered in the transcript but will not add to total marks obtained by the candidate for the award of the degree.

Int. Ass. = Internal Assessment

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC511
Course Title: Phycology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	The objective of the course is to make students familiar with the algal diversity, their structure, physiology and evolution.
CO-2	Students will learn about the algae to provide a basis for understanding the evolutionary pathways to higher plants.
CO-3	Students will be able to understand the role of algae in environment as primary producers, suppliers of nutrition and resources for humans.

Unit-I

Habitat and habit of algae, Comparative account of important system of classification (Fritsch F.E., 1945 and Robert E. Lee, 2008).

Organization of thallus, structure of algal cell, algal pigments and photosynthetic apparatus. Algal flagella, nutrition.

Unit-II

Comparative account of food reserves, reproductive diversity, life history patterns, nutrition, Origin & evolution of sex in algae.

Chlorophyta - ***Volvox, Hydrodictyon, Cladophora, Fritschiella, Oedogonium, Zygnema, Chara.***

Xanthophyta-***Vaucheria***

Unit-III

Phaeophyta - ***Ectocarpus, Laminaria, Dictyota, Fucus, Sargassum***.
Rhodophyta - ***Porphyra, Batrachospermum, Polysiphonia***.

Unit-IV

Cyanophyta - ***Nostoc, Oscillitoria, Rivularia, Spirulina, Stigonema,*** Rhythms and bioluminescence in Dinoflagellates, algal blooms.
Economic importance of algae, bacterial and fungal pathogens of algae, algae as indicators of water pollution.

Books Recommended

1. Robert E. Lee (2008). Phycology, Cambridge University Press, New York.
2. Ahluwalia, A.S. (Ed.) (2003). Phycology. Daya Publishing House, New Delhi-110035.
2. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae. Structure and Reproduction, Prentice Hall Inc. Englewood Cliffs, New York.
3. Kumar. H.D. and Singh, H.H. (1971). A Textbook on Algae, East – West Press Pvt. Ltd.
   New Delhi.
4. Kumar. H.D. (1999). Introductory Phycology, East – West Press Pvt. Ltd. New Delhi
5. Trivedi, P.C. (Ed.) (2001). Algal Biotechnology. Pointer Publishers, Jaipur.
6. Fritsch F.E. (1945). The Structure and Reproduction of Algae. Vol. II. Cambridge Univ. Press. Cambridge, London.

Course Outcomes:

CO-1	Comprehend the diversity of lower cryptogams ***i.e.*** Algae. Collection and study of algae from different localities, their identification up to generic level.
CO-2	Recognization of the morphology, anatomy, physiology, reproduction and lifecycle pattern of algae.
CO-3	To understand the phenomenon of algal blooms and bioluminescence.

Suggested Practicals

1. Sectioning and permanent mounting of thalli of various species of Cyanophyta, Chlorophyta,
2. Charophyta, Phaeophyta, Rhodophyta.
3. Study of diversity of freshwater and sewage water algae.
4. Preparation of synthetic media and cultivation of algae
5. Interpretation of electron micrograph of some algae.
6. Biochemical analysis of pigments present in algal species
7. Studies on habit and habitat of various algae.
8. Estimation of total carbohydrates from fresh water algae.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC512
Course Title: Mycology and Plant Pathology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	Students will get insight on general characteristics, lifecycle, ecology of different members of each group of fungi; importance of mushroom; symbiotic association in lichen; applied mycology which deals with importance of fungi in agriculture, pharmaceutical and other industries
CO-2	Students will learn about the etiology and symptology of several bacterial and viral diseases in plants. Prevention and control of plant diseases
CO-3	Students can learn about the role of fungi in biotechnology, food industry, agriculture and production of biological controls

Unit -I

Introduction to fungi; history of mycology, general characteristics of fungi and fungi like organism, somatic structures and hyphal forms, modes of reproduction, life cycle patterns, growth and differentiation, fungal nutrition, fungal nomenclature, classification and phylogeny.

Origin and evolution of Sex in fungi including hormonal control, heterothallism, homothallism & parasexual cycle. Economic importance of Fungi with respect to role in industry, Medicine, Mycorrhizae in agriculture, Biological control, Edible fungi, mushroom cultivation.

Unit -II

KINGDOM: FUNGI

General Characteristics, Life history & Classification of the following:

Phylum: ***Chytridiomycota***
Monoblepharis
Phylum: ***Neocallimastigomycota***
Neocallimastrix
Phylum: ***Blastocladiomycota***
Allomyces, Physoderma
Phylum: ***Zygomycota***
Rhizopus, Phycomyces, Pilobolus, Entomophthora,
Phylum: ***Glomeromycota***
Glomus
Phylum: ***Ascomycota***
Saccharomyces, Morchella, Peziza, Aspergillus, Claviceps, Xylaria

Unit -III

Mitosporic: Fungi
Pyricularia, Veriticillium
Phylum: ***Basidiomycota***
Agaricus, Amanitia

KINGDOM: CHROMISTA

History, classification, structure, development, reproduction, life history of the following:

Phylum: ***Oomycota***
Saprolegnia

KINGDOM: PROTOZOA

History, classification, structure, development, reproduction, life history of the following

Phylum: Mycetozoa
Physarum, Stemonites, Dictyostelium, Plasmodiophora

Unit -IV

Principles and methods for the prevention and control for plant diseases, modelling and disease forecasting, plant quarantine, defense mechanisms of plants against pathogens, plant disease clinics, prediction of disease control decisions.

Symptomatology, identification, etiology and control measures of the following plant disease:

Causal Organism	**Disease**
Synchytrium	Potato Wart
Taphrina	Peach Leaf Curl
Venturia	Apple Scab
Erysiphe	Powdery Mildew of Barley
Alternaria	Early Blight of Potato
Cercospora	Tikka Disease of Groundnut
Fusarium	Wilt of Cotton and Arhar
Helminthosporium	Brown Spot Disease in Rice
Colletotrichum	Anthracnose Disease of Chillies
Puccinia	Rust of Wheat
Ustilago	Loose Smut of Wheat

Tilletia	Karnal Bunt of Rice
Pythium	Damping-off Disease
Phytophthora	Late Blight of Potato, Blight of ***Colocasia***
Albugo	White Rust of Crucifers

Books Recommended

1. Agrios GN. (2005). Plant Pathology. Fifth Edition, Elsevier Academic Press, London.
2. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4th edition. John and Sons, Inc.
3. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd. 3.
4. Hait G. (2016). A Textbook of Mycology. New Central Book Agency (P) Ltd. London.
5. Mehrotra RS, Aggarwal A. (1990). Plant Pathology. Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.
6. Pandey BP. (2008). Plant Pathology, S. Chand and Company Pvt. Ltd., New Delhi.
7. Singh RP. (2012). Plant Pathology, Kalyani Publishers, New Delhi.
8. Sumbali G. (2005). The Fungi. 1st edition. Narosa Publishing India House.
9. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
10. Webster J. (1980). Introduction to Fungi. 2nd edition. Cambridge University Press.

Course Outcomes:

CO-1	Comprehend the diversity of lower cryptogams ***i.e.,*** Fungi. Collection and study of fungi from different localities, Identification up to generic level.
CO-2	Recognization of the morphology, anatomy, physiology, reproduction, lifecycle pattern and causative agent for different plant diseases.
CO-3	Distinguish between the harmful and beneficial fungal genera.
CO-4	After studying phytopathology, students get vast understanding of disease causing factors and simultaneous preventive controls for the several plant diseases.

Suggested Practicals

1. Principles & working of instruments in the Mycology & Plant Pathology laboratory.
2. Characterization of disease symptoms and identification of pathogenic organisms (rust of wheat, damping off disease, white rust of crucifers, early and late blight of potato, loose smut of wheat, wilt of cotton, tikka disease of groundnut, citrus canker, leaf curl of papaya, yellow vein mosaic of bhindi, red rot of sugarcane, anthrocnose of chillies.)
3. To study type genus: ***Saccharomyces, Rhizopus, Mucor, Peziza, Morchella and Agaricus***.
4. Comparative biochemical and physiological observations of healthy and infected leaves.
5. Ocular micrometry of spores of pathogenic fungi.
6. Obsevations on rhizosphere of infected plants.
7. Measurement of radial growth of fungi in petri plates.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC513
Course Title: Genetics and Evolution

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	Students will study the concept of classical versus molecular concept of the gene.
CO-2	To study the structure of DNA and detailed mechanism of replication in prokaryotes and eukaryotes.
CO-3	To study cell cycle, its regulation, genetic disorders, correlation between mutagenicity and carcinogenecity.
CO-4	To study the transposable genetic elements and reulation of gene expression in prokaryotes.
CO-4	To study the concept of polyploidy and organic evolution.

Unit-I

Fine Structure of Gene: Classical versus molecular concept of the gene, the cis-trans complementation for functional allelism, limitation of cis-trans test, fine structure of phage T4 II Locus; fine structures of gene and "Complex loci" in eukaryotes, genes within genes in phage ϕX124, over-lapping genes; concept of split gene; pseudogenes, nucleotide sequences.
Genetic Material: Properties and replication, proof that the genetic information is stored in DNA, the Watson-Crick Model, the double helix, alternate forms of double helix, DNA replication, initiation and primer problem, complex replication apparatus, rolling circle replication of phage ϕ X124.

Unit-II

Genetic regulation of cell cycle: Homologous chromosomes, polytene and lampbrush chromosomes, Oncogenes, biochemistry and molecular biology of cancer, genetic disorders, Correlation between mutagenicity and carcinogenecity.

Mutations: Definition, types, detection in bacteria, ***Neurospora***, maize and ***Drosophila***; molecular basis of mutations; induced mutations (radiation and chemical mutagenesis), DNA repair mechanisms, DNA recombination mechanism, mutagen dosage.

Unit-III

Transposable Genetic Elements: Introduction, transposable elements in bacteria (Is elements, Tn 3 family), transposable elements in eukaryotes "Yeast Ty elements", maize transposons, ***Drosophila*** transposons, significance of transposable elements.

Somatic Crossing Over: Molecular mechanism of crossing over, gene conversion, ordered and unordered tetrad analysis, somatic cell hybridization.

Regulation of Gene Expression in Prokaryotes: The Operon model, lac, an inducible operon, trp, a repressible operon, positive control of the lac operon by CAP and cAMP, complex regulation of ara operon, attenuation.

Unit-IV

Polyploids: Inheritance pattern in autopolyploids (chromosome and chromatid segregation), diplodization, role of polyploidy in evolution.

Palaeontology and Evolutionary History: The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants.

Organic evolution: Review of theories of evolution. Hardy-Weinberg Law, speciation, modes of speciation (gradual and abrupt).

Books Recommended

1. Berger, M.W. (1976). Genetic, MacMillan Publishing Co. Inc, New York.
2. Gardner, E.J. Simons, M.J. and Snustad, D.P. (2006). Principles of Genetics, John Wiley & Sons, Inc., New York, Toronto.
3. Klug and Cummings. (1997). Concepts of Genetics, Prentice Hall International Inc., New Jersey.
4. Khush. G.S. (1973). Cytogenetics of Aneuploids, Academic Press, New York.
5. Lewin, B. (1997) Genes VI. Oxford University Press, Oxford.
6. Martz C.P. T. and Yong, W.J. (1988). Cytogenetics. Rekha Printers, New Delhi.
7. MinKoff, E.C. (1983). Evolutionary Biology. Addison-Wesley Publishing Co., Massachussettes.
8. Schulz -Schaeffer, J., (1980). Cytogenetics of Plants, Animals and Human, SpringerVerlag, New York.
9. Verma, P.S. and Aggarwal, V.K. (2014). Cell Biology, Genetics, Molecular Biology, Evolution & Ecology, S. Chand & Co. Ltd., New Delhi.
10. Strickberger, M.W. (2015). Genetics. 3rd Ed. Pearson Education India.

Course Outcomes:

CO-1	Students will know about the concept of gene, chromosomes and DNA.
CO-2	Learn the process of DNA replication in prokaryotes and eukaryotes.
CO-3	Learn the mechanism of cell cycle and its regulation.
CO-4	Learn about the significance of transposable genetic elements.
CO-5	Learn the role of polyploidy in evolution and concept of speciation.

Suggested Practicals

1. Learning the cytogenetics laboratory-methods of microcopy, fixation, staining and dehydration
2. Meiotic and mitotic studies in ***Allium cepa***
3. Polyploidy induction methods in laboratory organisms-treatment with colchicine
4. Studies on chromosomal aberrations in ***Allium cepa***-using DDT and other pesticides
5. DNA isolation, purity and quantitative estimations.
6. Gel Scoring and data analysis
7. Demonstration of principles of genetics in ***Pisum sativum***
8. Numerical exercises on pedigree analysis, gene interactions, population genetics, chi-square and probability
9. Morphological observations in chromosomes- study on polytenic chromosomes of ***Drosophila***.
10. Karyotypic analysis of laboratory organisms-***Allium cepa, Vicia faba, Drosophila***
11. Studies of human karyotyes and genetic diseases associated.
12. Demonstration of Hardy-Weinberg Law using pea seeds.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC514
Course Title: Plant Physiology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To understand the plant cell and physiology, water relations and transpiration and mineral nutrition, especially nitrogen metabolism.
CO-2	Understand qualitative and quantitative analysis of the plant contents.
CO-3	Students will learn the techniques related to plant physiology so that they can design their own experiments.

Unit-I

Properties of water: soil-plant relations, water relations kinetic theory, chemical and potential gradients, Raolt's Laws, rate of diffusion, free energy of water, atmospheric H_2O, measurement of water potential components.
Energy metabolism (concept of the energy): Thermodynamic principles in biology, energy rich bonds, weak interactions, coupled reactions and oxidative phosphorylations, group transfers, biological energy transducers, bioenergetics.

Unit-II

Signal transduction: Overview, receptors and G-proteins, phospholipid signalling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signalling mechanisms e.g., two-component sensor-regulator system in bacteria and plants, sucrose-sensing mechanism.

Unit-III

Nitrogen Metabolism: Introduction, Overview of nitrogen in the biosphere and in plants, Overview of nitrogen fixation, Enzymology of nitrogen fixation, symbiotic nitrogen fixation, Ammonia uptake and transport, Overview of nitrate uptake and reduction, Nitrate reduction, Interaction between nitrate assimilation and carbon metabolism,

Unit-IV

Sulphur Metabolism: Overview of sulphate assimilation, Sulphur chemistry and function, Sulphur uptake and transport, the reductive sulphate assimilation pathway, Synthesis and function of glutathione and its derivatives.

Books Recommended

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2002). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland.
2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. (eds) (1997). Plant Metabolism (second edition). longman, Essex.
3. Galston, A.W. (1989). Life Processes in Plants. Scientific American Library, Springer-Verlag, New York.
4. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (eds) (1999). Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam.
5. Hopkins, W.G. (2013). Introduction to Plant Physiology. John Wiley & Sons, Inc., New York.
6. Lodish, H., Berk, A., Zipursky, S.I., Matsudaira, P., Baltimore, D. and Darnell, J. (2000). Molecular Cell Biology (fourth edition). W.H. Freeman and Company, New York.
7. Moore, T.C. (1989). Biochemitry and Physiology of Plant Hormones (second edition). Springer-Verlag, New York.
8. Nobel, P.S. (1999). Physiochemical and Environmental Plant Physiology (2nd Ed.). Academic Press, San Diego.
9. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology (4th edition). Wadsworth Publishing Co., California.
10. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
11. Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th edition). Sinauer Associates, Inc., Publishers, Massachusetts.

Course Outcomes:

CO-1	After completion of the course, the students will familiar with various physiological aspects involved in the plant development.
CO-2	Understanding the mechanism of photosynthesis, respiration and nitrogen and lipid metabolism.
CO-3	The students will able to isolate starch, pectin and various nutritive products from the plants.
CO-4	Equip students with skills and techniques related to plant physiology.

Suggested Practicals

1. Study on principles of pH metry, spectroscopy
2. Studies on preparation of various concentrations of solutions
3. Permeability observations on plasma membrane using different concentrations of organic solvents.

4. Effect of temperature on permeability of plasma membrane.
5. Preparation of standard curve of protein (e.g.BSA) and determine the protein content in unknown samples.
6. Estimation of activity of enzyme catalase
7. Estimation the activity of enzyme glutathione reductase.
8. Determination of osmotic potential of vacuolar sap by plasmolytic method.
9. Determination of the water potential of any tuber by constant weight method.
10. Determination of the water potential of any tuber by Chardakov's dye method.
11. Separation of amino acids in a mixture by paper chromatography and their identification by comparison with standards.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC515
Course Title: Introduction to Computers and Basic Bioinformatics

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To be proficient in office automation applications.
CO-2	Handle the word processing software.
CO-3	Understand that in today's commercial world, automation helps the users with a sophisticated set of commands to format, edit, and print text documents.
CO-4	Use it as valuable and important tools in the creation of applications such as newsletters, brochures, charts, presentation, documents, drawings and graphic images.
CO-5	To understand the bioinformatics tools and their applictions.

Unit-I

MS-Word-2010: Overview of word processing software, creating, saving and opening a new file in MS-Word, various formatting tools, paragraphs and sections, indents and outdents, lists and numbering, types of lists, Headings, styles, fonts and font size. Editing, positioning and viewing texts, Finding and replacing text, inserting page breaks, page numbers, book marks, symbols and dates, Inserting header, footer, mail merge.

Unit-II

MS-Excel-2010: Worksheet: Introduction to worksheet, worksheet basics, building a worksheet, moving within worksheet, entering data into worksheet, saving & quitting worksheet, opening and moving around in an existing worksheet, Working with Formulae: cell referencing, use of formulae, auto sum, copying formulae, absolute & relative addressing, working with ranges- creating, editing and selecting ranges, Previewing & Printing Worksheet: page setting, print titles, adjusting margins, page break, headers and footers.

Graphs and Charts: using wizards, various charts type, formatting grid lines & legends, previewing & printing charts.

Unit-III

MS-Power Point 2010: Introduction to MS Power Point, presentation overview, power point elements, exploring power point menu, entering information, presentation creation. Opening and saving presentation, slide view, slide sorter view, notes view, outline view, printing slides, formatting and enhancing text formatting

Unit-IV

Bioinformatics

Introduction to Bioinformatics, History of Bioinformatics, milestones, objectives and applications of Bioinformatics.

Introduction to Biological Databases, Types of Databases,

Literature Databases: PUBMED, PUBMED Central, European PUBMED Central

Nucleic acid and protein databases: GenBank, EMBL, DDBJ, SWISSPROT, UNIPROT.

Database Retrieval and Deposition Systems: SRS, Entrez, Bankit, Seqin, Webin

Biotechnological Databases: EST, SNP

Databases for species identification and classification: GBIF, taxonomy browser at NCBI.

Plant Genome Databases: TAIR, Rice Genome Annotation Project, Maize GDB

Structural Databases: PDB, NDB

Carbohydrates and lipid databases: Glyco Suite DB, LIPIDAT

Books Recommended

1. Mount D. W. (2004). Bioinformatics & Genome Analysis. Cold Spring Harbor Laboratory Press.
2. Baxevais B.F. and Quellette F. (2004). Bioinformatics A Practical Guide to the Analysis of Genes and Proteins. Wiley-Interscience.
3. Eidhammer I., Jonassen I. and Taylor W. R. (2004). Protein Bioinformatics: An Algorithmic Approach to Sequence and Structure Analysis. Mathematics.
4. Orengo C.A., Jones D.T. and Thornton J.M. (2003). Bioinformatics: Genes Proteins and Computers. Bios Scientific Pub.
5. Bourhe P. E. and Weissig H. (2003). Structural Bioinformatics (Methods of Structural Analysis). Wiley-Liss.
6. Sinha, P.K. (1998). Computer Fundamentals. BPB Publications, New Delhi.
7. Peter Norton's (1998). Introduction to computers, Tata McGraw-Hill Publishing Company Limited, New Delhi

Course Outcomes:

CO-1	Use word processors, spreadsheets, presentation software.
CO-2	Understand and create a database using MS Access.
CO-3	Describe the features and functions of the categories of application software.
CO-4	Understand the dynamics of an office environment.
CO-5	To understand the ability of bioinformatics tools in research and development.

Suggested Practicals

1) Introduction to MS Word, Creating Table in MS Word, Page Formatting, Printing, Page Layout
2) Mail Merge
3) Creating Slide Presentation in MS PowerPoint, Viewing the Slideshow, Adding Images in MS PowerPoint, Inserting Sound and Videos in MS PowerPoint
4) Introduction to MS Workbook
5) Creating different worksheets in MS Excel, Inserting Charts in MS Excel, Introduction to various functions in MS Excel
6) Introduction to various Literature Databases: PUBMED, Google Scholar, Scopus
7) Introduction to Nucleotide databases i.e., NDB, GenBank, EMBL and DDBJ
8) Introduction to protein databases i.e. PDB, SWISS-PROT
9) Carbohydrates and lipid databases: GlycoSuiteDB, LIPIDAT
10) Plant Genome Databases: TAIR, Rice Genome Annotation Project, Maize GDB

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC516
Course Title: Theoretical Biology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the questions. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven questions with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks.

Course Objectives:

CO-1	To enable the students to learn the concept of function, limit and continuity.
CO-2	To help the students to understand the concept of matrices and determinant.
CO-3	To acquaint the students with the properties of straight line and circle.
CO-4	To solve problems related to derivatives and integrals.
CO-5	To differentiate definite integral and indefinite integral.

Unit-I

Linear Function: y=ax and y=ax+b
Power Function: $y=ax^n$, quadratic equation.
Periodic Function: Sine and cosine, trigonometric relations.
Exponential and Logarithmic Functions: Exponential function $y=aq^x$, logarithmic function.
Probability: Concept of probability, permutations and combinations.

Unit-II

Differentiation and Integration: Limit Growth rates, instantaneous rate of change, differentiation of some important functions, product rule and quotient rule of differentiation, chain rule of differentiation.
Integration: Integrals, definite integral, rules of integration, second derivative.
Exponential and Logarithmic Functions: $d/dx(e^x)$, d/dx(ln x), integral of 1/x.

Unit-III

Statistics: Mean, standard deviation, standard error, 't' test, chi square test.
One way ANOVA, simple linear regression and correlation.

Unit-IV

Matrix Operations: Addition, subtraction, multiplication, inversion, latent root, latent vector.

Books Recommended

1. APHA-Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, DC. 23rd edition
2. Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California. 3rd edition
3. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin. 2nd edition
4. Begon, M. Harper, J.L. and Townsend, C.R. (1996). Ecology, Blackwell Science, Cambridge. 6th edition
5. Brady, N.C. (1990). The Nature and Properties of Soils. Macmillan.
6. Chapman, J.L. and Reiss, M.J. (1988). Ecology: Principles and Applications. Cambridge University Press, Cambridge.
7. De, A.K. (1990). Environmental Chemistry. Wiley Eastern Pvt. Ltd., New Delhi. 6th edition
8. Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment. Cambridge University Press, Cambridge.
9. Hill, M.K. (1997). Understanding Environmental Pollution. Cambridge University Press, Cambridge.
10. Kormondy, E.J. (1996). Concepts of Ecology.Prentice Hall of India Pvt. Ltd., New Delhi.
11. Krebs, C.J. (1989 Ecological Methodology. Harper and Row, New York, USA.)
12. Koromody, E.J. (1981). Concepts of Ecology.Prentice Hall of India Pvt. Ltd., New Delhi. 3rd edition
13. Ludwig, J and Reynolds, J.F. (1988). Statistical Ecology, John Wiley & Sons, New York.

Course Outcomes:

CO-1	Students will be able to learn the concept of function, limit and continuity.
CO-2	Students will be able to understand the concept of matrices and determinant.
CO-3	Students will understand the properties of straight line and circle.
CO-4	Students will be acquainted with the matrices, determinants, derivatives and integrals.
CO-5	Students will be able to differentiate definite integral and indefinite integral

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC521
Course Title: Bryology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To understand the bryophyte diversity with special reference to Indian work.
CO-2	To study the general account of thallus organization, classification, reproduction and life history of bryophytes.
CO-3	To study economical and ecological importance of bryophytes.
CO-4	To study about the conservation of bryophytes.

Unit-I

Habitat, habit, distribution and classification of Bryophytes, origin of bryophytes (including fossil records), primitive vs advanced/derived characters, economic importance.

Unit-II

Comparative morphological account of gametophytes and sporophytes and life cycle of:

i. Hepaticopsida – (***Riccia, Marchantia, Targionia, Cyathodium, Lunularia, Sphaerocarpus, Calobryum, Porella, Pellia***).
ii. Anthocerotopsida – (***Anthoceros***)
iii. Bryopsida (***Sphagnum, Andrea, Funaria***)

Unit-III

Origin of land habit, Evolution of gametophyte and sporogonium in liverworts and mosses (taking examples of above mentioned orders), Spore dispersal, Peristome teeth in mosses.

Unit-IV

Morphogenetic changes in moss protonema, Characteristic endohydric, ectohydric and myxohydric bryophytes, Palynology of Bryophytes, Methods to conserve Bryophytes at national level.

Books Recommended

1) Bower, F.O. (1908). The Origin of Land Flora. The MacMillan Press, London.
2) Campbell, D.R. (1985). The Evolution of Land Plants (Embryophyta) Reprinted Central Book Depot, Allahabad
3) Smith, G.M. (1955). Cryptogamic Botany. Vol. II, Tata McGraw Hill Publishing Co. Ltd.New Delhi.
4) Stewart, W.N. (1983). Palaeobotany and Evolution of Plants. Cambridge University Press, London.
5) Taylor, T.N. (1981). Palaeobotany. An Introduction to Fossil Plant Biology, McGraw Hill Book Company, New York.
6) Kumar, S.S. (1984). An Approach towards Phylogenetic Classification of Mosses, Jour. Hattori Bot. Lab. Nichinan, Japan.
7) Goffinet, B. and Shaw, A.J. (2000). Bryophyte Biology, Cambridge University Press, Cambridge, pp. 476

Course Outcomes:

CO-1	Students will understand morphological, anatomical and developmental patterns in the bryophytes.
CO-2	Understanding reproduction and life cycle pattern in bryophytes.
CO-3	Economic values of the bryophytes.

Suggested Practicals

1. Morphological, reproductive and anatomical study of representative members of the bryophytes studied in theory using cleared whole mount preparation and sectioning (***Riccia, Marchantia, Porella, Pellia, Funaria, Sphagnum, Polytrichum***).
2. Studies on habit and natural habitat of bryophytes.
3. Study of Peristome teeth (WM).
4. Study of Scales, rhizoids (WM).
5. Study of dehiscence pattern of sporogonium.

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC522
Course Title: Diversity and Biology of Gymnosperms

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study the habitat and distribution of gymnosperms in India.
CO-2	To study the morphology, developmental biology, reproductive biology of Gymnosperms.
CO-3	To study the phylogenetics, evolutionary tendencies in relation to male and female sporophylls.
CO-4	Economic importance of the gymnosperms.

Unit-I

Gymnosperms, diversity of structure and complexity. Classification of gymnosperms and their distribution in India and in the globe in time and space. Geological time scale and important geological formations in India.

Unit-II

Morphology, general account, structure and reproduction of Progymnosperms (Aneurophytales, Archeopteridales etc.): Cycadofilicales, Glossopteridales, Pentoxylales, Cordaitales.

Unit-III

Morphology, general account, structure and reproduction of Cycadeoidales, Cycadales, Ginkgoales, Coniferales, Taxales, Ephedrales, Welwitschiales and Gnetales.

Unit-IV

Evolutionary tendencies in gymnosperm organography and life cycle with particular reference to male and female sporophylls, cones, ovules, seeds and archegonia, Pollination mechanisms, cytology of Gymnosperms, Economic importance of Gymnosperms.

Books Recommended

1. Arnold, C.A. (1947) An Introduction to Palaeobotany. McGraw Hill Book Company, New York.
2. Bhatnagar, S.P., and Moitra, A. (1996) Gymnosperms. New age International, Private Limited.
3. Biswas, C., and Johri, B.M. (1997) Gymnosperms. Narosa Publishing House, New Delhi.
4. Brown, H.P. (1989) An Elementary Manual of Indian Tree Technology, Dehradun
5. Chamberlain C.J. (1935) Gymnosperms: Structure and Evolution CBS Publishers and Distributors, N. Delhi.
6. Coulter, J.M., and Chamberlain, C.J. (1917) Morphology of Gymnosperms (Reprinted) Central Book Dept. Allahabad.
7. James, W. (2015). The Gymnosperms Hand Book, Plant Gateway Ltd.
8. Sporne, K.R. (1965). The Morphology of Gymnosperms, Published by Hutchinson University Library.
9. Stewart M. (2007). Classfication of Life, Published by Twenty First Century Books.

Course Outcomes:

CO-1	Understanding the morphological, anatomical and developmental patterns in the Gymnosperms.
CO-2	Understanding about the reproductive parts their development and mechanism of reproduction and life cycle pattern.
CO-3	Evolutionary tendencies and organography in gymnosperms with particular reference to male and female sporophylls, cones, ovules, seeds and archegonia.
CO-4	Economic value ***i.e.,*** timber, secondary metabolites, resins ***etc***.

Suggested Practicals

1. Study of morphology, structure and reproduction in ***Cycas, Pinus, Cedrus, Ginkgo, Ephedra, Taxus, Podocarpus, Gnetum.***
2. Study of leaf and stem anatomy in ***Pinus, Cedrus, Picea, Abies, Agathis, Taxus, Podocarpus, Araucaria, Ginkgo, Ephedra, Gnetum.***
3. Study of fossils: ***Williamsonia.***
4. Understanding wood anatomy using T.S, T.L.S and R.L.S in ***Pinus*** and ***Cedrus.***
5. Study of secondary growth in stem and root.
6. To submit twenty five permanent slides.

M.Sc. (BOTANY) SEMESTER-II

Programme: MBOT
Course Code: BOTC523
Course Title: General Microbiology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study the principles of microscopy, microscopic and staining techniques, sterilization methods and pure culture methods.
CO-2	To study the structure and classification of bacteria and viruses.
CO-3	To gain the knowledge on bioremediation and its application to control water and soil pollution.
CO-4	To study about the role of air in spreading microbes and its control.
CO-4	To study the role and benefits of microbes in industries for human welfare.
CO-5	To study the different modes (physical & chemical) of control for microorganisms.

Unit-I

Methods in Microbiology: Basic principles of microscopy, micrometry, staining, sterlization methods; culture media, pure culture methods. Classification of bacteria (Bergey's system) characteristics of each group, Nutrition of bacteria, nature of virulence, toxins and extracellular enzymes of pathogenic bacteria, conjugation, transformation and transduction. Nomenclature and classification of plant viruses, transmission of plant viruses with control measures, Viroids and origin of viruses, morphology and nature of virus particles, infection and replication with reference to TMV and bacteriophage, viral disease with reference to encephalitis, hepatitis, AIDS, rabies, foot and mouth diseases.

Unit-II

Environmental Microbiology: Sewage (waste water) treatment: Ecological impact of raw sewage on receiving water, public health impact of raw sewage discharge. Primary, secondary and tertiary waste water treatments. Total coliform bacteria analysis, fecal coliform bacteria analysis in drinking water. Land fills and composting. Bioremediation:

Biodegradative organisms, advantages of bioremediations, problem associated with bioremediation and methodology of bioremediation.

Unit-III

Aeromicrobiology: Important airborne plant, animal and human pathogens, important airborne toxins, nature of bioaerosols, aeromicrobiological pathways and sampling devices for the collection of bioaerosols. Industrial Microbiology: The Microbes: Primary and secondary metabolites, major industrial products: foods, flavouring agents and food supplements vitamins and beverages; organic acids; enzymes and microbial transformation; inhibitors; genetically engineered microorganisms – Human insulin and Human growth hormones and vaccines.

Unit-IV

Control of Microorganisms by Physical and Chemical Means: Fundamentals of control, physical agents, high temperature, low temperature, desiccation, osmotic pressure, radiation, surface tension and interfacial tension, filtration, characterisation of an ideal antimicrobial chemical agent, selection of a chemical agent for practical application and major groups of antimicrobial agents.

Books Recommended

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
2. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
4. Webster, J. (1980). Introduction to Fungi, 2nd Ed., Cambridge University Press, Cambridege, London.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
6. Schlegel H.G. (1993). General Microbiology. 7th Ed. The University of Cambridge.

Course Outcomes:

CO-1	To know about the basic principles and application of microscopy and staining techniques.
CO-2	To know the structure and types of bacteria. virus and effects on human health.
CO-3	To know about the treatment of waste water in controlling water pollution.
CO-4	To know about the process of bioremediation and its application to control water and soil pollution from the degraded sites.
CO-4	To know about the procedure and techniques to control the growth of microorganisms.
CO-5	To know about conrol of mocrobial growth, role and application of antimicrobial agents.

Suggested Practicals

1. Acquaintance with working, principle, parts and precautions of most commonly used instruments in a microbiology lab
2. Calibration of microscope: determination of dimensions of microorganisms
3. Acclimatization with aseptic techniques-sterilisation, preparation and cultivation media for bacteria
4. To prepare temporary and permanent cotton plugs
5. To prepare solid and liquid culture media
6. To culture or cultivate bacteria
7. To stain and study bacteria
8. To measure bacterial cells through ocular micrometry
9. Microscopic examination of milk and curd
10. To isolate micro-organisms from mixed culture and grow a pure culture
11. Isolation of microbes from soil sample by streaking method
12. Isolation of micro organisms from given water sample by serial dilution.
13. Methylene blue reduction test for examining the microbial activity of milk
14. To study radial growth of fungi on nutrient media
15. To determine antibiotic staining of bacterial strain
16. Demonstration of Lambart Beer's law by colorimeter

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOT C524
Course Title: Cell Biology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study the structure and function of cell, cell division and cell cycle.
CO-2	Levels of structural organization, cell membrane structure and function.
CO-3	Structural organization and function of intracellular organelles.
CO-4	Organization of genes and chromosomes.
CO-5	Cell signaling and cellular communications.

Unit-I

Levels of Structural Organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.
Membrane Structure and Function: Structure of model membrane, lipid bilayer and membrane proteins, diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Unit-II

Structural Organization and Function of Intracellular Organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Unit-III

Organization of Genes and Chromosomes: Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.
Cell division and Cell Cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Microbial Physiology: Growth, yield and characteristics, strategies of cell division, stress response.

Unit-IV

Cell Signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

Cellular Communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Books Recommended

1. Alberts, B. Bracy, P. Lewis, J. Raff, M. Roberts K and Watson, J. (eds) (1994). Molecular Biology of the Cell, Garland Publishing, New York.
2. Cooper, G. M. (1997). The cell, A Molecular Approach ASM press, Washington, D. C.
3. Chandra Roy, S and DE Kumar, K. (2001) Cell Biology. New Central Book Agency (P) Ltd. Kolkata.
4. Darnell, J. Lodish, H. and Baltimore, D. (1990). Molecular Cell Biology, 2nd edition, Freeman, New York.
5. Derobertis, E. D. P. and Derobertis, E.M.F. (1987). Essentials of Cell and Molecular Biology. Hold Saunders – Philadelphia.
6. Holtzman, E. and Novikoff, A. B. (1984). Cells and Organelles. Saunder Philadelphia.
7. Hopkins, C. L. (1978). Structure and Functions of Cells. Saunders – Philadelphia.
8. Karp G. (1999). Cell and Molecular Biology.Concepts and Experiments, 2nd Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
9. Loewy, A. G., Siekevitz, P, Menningee, J. R., and Allant, J. A. N. (1991). Cell structure and Functions.An integrated Approach 3rd edition. Saunders College Publishing, Philadelphia, London.
10. Pollard. T.D. and Earnshaw, W.C. (2002) Cell Biology. Saunders, Philadelphia London. New York, St. Luis Sydney, Toronto.
11. Powar, C. B. (1990). Cell Biology. Himalaya Publishing House, Bombay.
12. Sadava, D. E. (1993). Cell Biology – Organelle, Structure and Fucntions. H. Jones and Bartlett- Boston.
13. Sheeler, P. and Binachi, D. E. (1983). Cell Biology, John Wiley, New York.

Course Outcomes:

CO-1	After successful completion of this course, students will be able to understand the concepts in Prokaryotic and eukaryotic Cell: The ultra-structural details and comparative assessment, different types of tissues in plants (meristematic and permanent), Plasma membrane: Molecular organization, current models and functions, transport across the membrane, protein sorting.
CO-2	Structural organization and functions of cell organelles and cytoskeleton.
CO-3	Organization of genes and chromosomes.
CO-4	Cell division (mitosis and meiosis), cell cycle regulation.
CO-5	Cell signalling and cell-cell communication.
CO-6	Conversant with Laboratory Technique viz. microscopy to study mitosis and meiosis, barr body, cyclosis, mitotic and meiotic index, alterations in chromosomes.

Suggested Practicals

1. Understanding the cytology laboratory- components of compound/electron microscope.
2. Examination of electron micrographs of eukaryotic cells with special reference to organelles.
3. Examination of various stages of mitosis and meiosis using appropriate plants material (e.g. onion root tips, onion flower buds).
3. Calculation of Mitotic and meiotic index from dividing root tip cells and pollen grains.
4. Study on cyclosis in ***Tradescantia*** and ***Hydrilla*** leaves.
5. Observations on Barr bodies in Squamous epithelium.
6. Preparation of Feulgen stained chromosomes in root tip cells.
7. Effect of colchicine on chromosome movements during mitosis.
8. Use of fluorescent dye to visualise cell components.

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC525
Course Title: Pteridology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	Origin of land habit, phylogenetic origin of pteridophytes and differentiation of organs in vascular plants.
CO-2	To study morphological, anatomical and developmental patterns in the pteridophytes.
CO-3	To study the developmental pattern and mechanism of reproduction and life cycle.
CO-4	To study the heterospory, seed habit and evolution of stelar system in pteridophytes.
CO-5	To study the spore structure and pattern of spore germination in ferns.
CO-6	Utility of ferns in phytoremediation.

Unit-I

Origin of land flora, differentiation of organs in vascular plants – Telome and Enation theories, significance and short comings, Stelar system in Pteridophytes.
Monophyletic vs polyphyletic origin of pteridophytes, pteridophytic life cycle with reference to alternation of generations, homologous and the antithetic theories of the origin of the sporophyte.

Unit-II

General characters and classification of pteridophytes, occurrence, comparative organography, systematics, reproduction and types of life cycle.
Psilopsida (***Rhynia, Psilophyton, Psilotum***)
Lycopsida (***Lycopodium, Sellaginella***)

Unit-III

Sphenopsida (***Equisetum***)
Pteropsida (***Ophioglossum, Pteris, Dryopteris, Marsilea, Salvinia, Azolla***)
Evolutionary trends in pteridophytes, prothallial evolution, organization and evolution of sorus in ferns.

Unit-IV

Apomictic life cycle, apogamy, apospory, heterospory and seed habit.
Spore structure, pattern of spore germination in ferns, Utility of fern for phytoremediation, Role of polyploidy and hybridization in speciation in ferns.

Books Recommended

1) Bower F.O. (1928). The Ferns, Vols. I – III. Cambridge University Press, Cambridge.
2) Parihar, N.S. (1992). The Biology and Morphology of Pteridophytes, Central Book
3) Rashid, A. (1991). An Introduction to Pteridophytes. Vikas Publishing House Pvt. Ltd. Distributors, Allahabad.
4) Sinnott, E.W. (1960). Plant Morphogenesis. McGraw Hill Book Company Inc. New York, Toronto, London.
5) Stewart, W.N. (1983). Palaeobotany and Evolution of Plants. Cambridge University Press, London.
6) Taylor, T.N. (1981). Palaeobotany. An Introduction to Fossil Plant Biology, McGraw Hill Book Company, New York.
7) Sporne, K.R. (1982). The morphology of Pteridophytes, B.I., Publications, Bombay, Delhi, Madras.

Course Outcomes:

CO-1	To know about morphological, anatomical and developmental patterns in the pteridophytes.
CO-2	To know about the reproductive parts their development and mechanism of reproduction and life cycle pattern.
CO-3	Economic value
CO-4	To understand the stelar evolution in pteridophytes.
CO-5	To understand the significance of paleobotany and its applications.

Suggested Practicals

1. Morphological, reproductive and anatomical study of representative members of the pteridophytes studied in theory using cleared whole mount preparation and sectioning (***Selaginella, Lycopodium, Equisetum, Pteris, Marsilea, Salvinia***).
2. Studies on habit and natural habitat of Pteridophytes.
3. Study of spore morphology.
4. Study of spore germination on Knop's medium.

M.Sc. (BOTANY) SEMESTER-II

Programme: MBOT
Course Code: BOTC526
Coure Title: Ecological Modelling and Forest Ecology

Credit Hours (Per Week): 3
Total Hours : 45
Maximum Marks : 50
Theory : 37
Internal Assessment : 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study the concept of population, population growth curves, interaction between species, predator and prey relations.
CO-2	To study the species diversity, species association and community classification.
CO-3	To study conservation methods and analyze the various threats to biodiversity.
CO-4	To study the forest types and climatic zones of India.
CO-5	To gain knowledge on environmental impact analysis, environmental law and policy.
CO-6	Remote sensing and their applications to assess vegetation distribution.

Unit-I

Exponential Population Growth: Differential equations, finite rate of increase, intrinsic rate of natural increase, stable age distribution, matrix model for population growth.
Logistic Population Growth: Differential model for population growth in limited environment.
Interaction Between Two Species: Competition – Differential equations, Leslie-Gower Model, Lotka-Volterra model for predator – prey interaction, Leslie model, simple epidemics.

Unit-II

Association Analysis and Community Classification: Chi-square, Cole's measures and point correlation coefficient for association, continuum concept.
Species Diversity: Species area relationships, species abundance relationships –information measures of diversity. Brillouin's measure, Shannon-Weaver measure, Simpson's measure. Extinction and formation of single populations, McArthur – Wilson theory of biogeography.

Unit-III

Production and Energy Flow: Production in animal populations, efficiency, measurement of ingestion. Measurement of production in plants, litter decomposition.
Forest types, climatic region of India, Central, characters and distribution of different forest type of India, Salient features of Indian forest act 1972, different methods employed for conservation of forest, Social and urban forestry.

Unit-IV

Environmental Law & Policy: Constitutional provisions, Water (prevention and control of pollution) Act, 1974, Air (prevention and control of pollution) Act, 1981, Environment ProtectionAct, 1986, Forest (Conservation) Act, 1980, National Biodiversity Act, Joint Forest Management Committee, Medicinal Plants Conservation Act (MPCA), Access Benefit Sharing (ABS), Wildlife (Protection) Act, 1972, the concept of biosphere reserves, International environmental perspectives.
Remote Sensing: Aerial photography image interpretation, digital image processing, remote sensing in ecology and forestry, agriculture, landscape analysis, Methods & theory of remote sensing.

Books Recommended

1. APHA-Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washingtonn, DC.
2. Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plan Ecology, Benjamin/Cummings Publication Company, California.
3. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.
4. Begon, M. Harper, J.L. and Townsend, C.R. (1996). Ecology, Blackwell Science, Cambridge.
5. Brady, N.C. (1990). The Nature and Properties of Soils. Macmillan.
3. Chapman, J.L. and Reiss, M.J. (1988). Ecology: Principles and Applications, Cambridge
   University Press, Cambridge.
4. De, A.K. (1990). Environmental Chemistry. Wiley Eastern Pvt. Ltd., New Delhi.
5. Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment, Cambridge
   University Press, Cambridge.
6. Hill, M.K. (1997). Understanding Environmental Pollution. Cambridge University Press,
   Cambridge.
7. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.
8. Krebs, C.J. (1989) Ecological Methodology. Harper and Row, New York, USA.)
9. Koromody, E.J. (1981). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.
10. Ludwig, J and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
11. Magurran, A.E. (1988). Ecological Diversity and its Measurement. Chapman & Hall, London.

12. Mason, C.F. (1991). Biology of Freshwater Pollution, Longman.
13. Misra, R. (1968). Ecology Work Book. Oxford & IBH, New Delhi.
14. Moldan, B. and Billharz, S. (1997). Sustainability Indicators. John Wiley & Sons, New
    York.
15. Moore, P.W. and Chapman, S.B. (1986). Methods in Plant Ecology. Blackwell Scientific
    Publications, Cambridge.
16. Muller-Dombois, D. and Ellenberq, H. (1974). Aims and Methods of Vegetation Ecology, Wiley, New York.
17. Odum, E.P. (1971). Fundamentals of Ecology, Saunders, Philadelphia
18. Odum, E.P. (1983). Basic Ecology. Saunders, Philadelphia.
19. Pielou, E.C. (1984). The Interpretation of Ecological Data, Wiley, New York.
20. Poole, R.W. (1974). An Introduction to Quantitative Ecology. McGraw Hill Book Co.,
    New York.
21. Smith, R.L. (1996). Ecology and Field Biology. Harper Collins, New York
22. Forest Ecology (3rd Edition) by James P. Kimmins Publisher Benjamin Cummings (2003)
23. Introduction of Forestry and Natural Resources (2013) by Donald L. Grebner, bettinger and Siry, Publisher Academic Press.
24. Forest Ecosystem by David A. Perry, Ram Oren and Stephan C. Hart (2nd Edition, 2008) Publisher Johns Hopkins University Press.
25. Introduction to remote sensing (5th Edition, 2011) by Jmes B. Campbell and Randolph H. Loynne, Publisher The Guilford Press.

Course Outcomes:

CO-1	On completion of this course the students are able to analyze various population growth curves, interaction between species, predator prey interactions.
CO-2	Association analysis, community classification and species diversity.
CO-3	To analyze the threat and suggest conservative measures.
CO-4	The students are also trained in the environmental impact analysis, environmental law and policy.
CO-5	Remote sensing, their methods and theories.

Suggested Practicals

1. To determine minimum size and number of quadrats required for reliable estimate of biomass in grassland.
2. To find out association between grassland species using chi square test.
3. To analyse plant communities using Bra-Curtis ordination method.
4. To determine soil moisture content, porosity, bulk density of different soil samples collected from different locations.
5. To determine Na, K concentration of water sample using flame photometer.
6. To determine water holding capacity of different soil samples.
7. To determine percent organic C and organic matter in different soil samples.
8. To estimate chlorophyll content in SO_2 fumigated and unfumigated plant leaves.
9. To estimate rate of CO_2 evolution from different soil using soda lime or alkali absorption method.
10. To determine sulphate content of water samples.
11. To determine O_2 content of water sample.

M.Sc. (BOTANY) SEMESTER-III
Course Code: BOTC611
Course Title: Plant Morphogenesis

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.

Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.

Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.

Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To understand the concept of morphogenesis, growth patterns, correlation within and among plant parts, and developmental patterns.
CO-2	To understand the plant symmetries and differentiation in relation to plant morphology.
CO-3	To study the concept of totipotency, tissue culture and regeneration in plants.
CO-4	To study the abnormal growth development in plants and effects of various abiotic factors in controlling plant morpholgies.

Unit-I

Morphogenesis: Definition and terminology

Growth: Definition, cellular basis of growth, meristem, determinate and indeterminate growth.

Morphogenesis Modeling: Quantitative Models of Plant Morphogenesis

Correlation: Physiological and genetic correlations.

Polarity: Polarity as expressed in external and internal structures, polarity in isolated cells, polarity in plasmodia and coenocytes, physiological manifestations of polarity, developmental patterns.

Unit-II

Symmetry: Inorganic and organic symmetries, radial symmetry, bilateral symmetry, dorsiventral symmetry, development of symmetry.

Differentiation: Growth and differentiation, differentiation as expressed in structure, external and internal differentiation.

Unit-III

Plant Cell Tissue and Organ culture: Definition and Applications, Totipotency, Dedifferentiation, Redifferentiation.

Regeneration: Regeneration in lower plants, regeneration in higher plants, reconstitution, restoration, reproductive regeneration.

Tissue Mixtures: Stock – scion interrelations, chimeras, somatic mutations.

Unit-IV

Abnormal Growth: Abnormal development of organs, production of new types of organized structures, amorphous structures.

Morphogenetic Factors: Introduction to factors-light, water, temperature, physical factors, genetic factors and chemical factors in general.

Books Recommended

1. Abley, K., Barbier de Reuille, P., Strutt, D., Bangham, A., Prusinkiewicz, P., Marée, A. F. M., et al. (2013). An intracellular partitioning-based framework for tissue cell polarity in plants and animals. ***Development*** 140, 2061–2074. doi: 10.1242/dev.062984
2. Alt, S., Ganguly, P., and Salbreux, G. (2017). Vertex models: from cell mechanics to tissue morphogenesis. ***Philos. Trans. R. Soc. Lond. Ser. B Biol. Sci.*** 372:20150520. doi: 10.1098/rstb.2015.0520
3. Ainsworth, C. (2006), Flowering and its Manipulation, Annual Plant Reviews, Vol. 20. Blackwell Publishing, Oxford, U.K.
4. Bassel, G. W., and Smith, R. S. (2016). Quantifying morphogenesis in plants in 4D. ***Curr. Opin. Plant Biol.*** 29, 87–94. doi: 10.1016/j.pbi.2015.11.005
5. Bhojwani, S.S. and Bhatnagar, S.P. (1975), The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd, Delhi.
6. Bhojwani, S.S. and Razdan, M. K. (1996), Plant Tissue Culture: Theory and Practice, a Revised Edition. Elsevier, a division of Reed Elsevier India Private Limited.
7. Eames, A.J. (1961) Morphology of the Angiosperms. McGraw Hill Book Company Inc., New York.
8. Maheshwari, P. (1950), An Introduction to the Embryology of Angiosperms. McGraw Hill Book Company Inc., New York

9. Marconi, M and Wabnik, K. 2021. Shaping the Organ: A Biologist Guide to Quantitative Models of Plant Morphogenesis. Frontiers in Plant Science, Sec. Plant Biophysics and Modelinghttps://doi.org/10.3389/fpls.2021.746183.
10. Sinnot, E.W. (1960), Plant Morphogenesis, McGraw Hill Book Company Inc., New York
11. Street, H. E. (1977), Plant tissue and cell culture. University of California Press, Berkeley.

Course Outcomes:

CO-1	Students learn the concept of different growth patterns, plant coorelations and role of polarity in plant morpholgy.
CO-2	Understand the role of symmetry and differentiation in plant growth.
CO-3	Learn about the techniques and applications of plant tissue culture.
CO-4	Understand the causes of abnormal growth in plants.
CO-4	Learn the role of various abiotic factors in plant morphology.

Suggested Practicals

1. Emasculation, bagging, hand pollination to study pollen germination, seed set and fruit development. Study of cleistogamous flowers and their adaptations.
2. Study of nuclear and cellular endosperm through dissection and staining.
3. Isolation of zygotic globular, heart shaped, torpedo stage and mature embryos from suitable seeds.
4. Study of seed dormancy and methods to break dormancy.
5. To Study the primitive and advanced characters of plants in angiosperms.
6. Study of various methods of asexual reproduction and vegetative reproduction.
7. To Study the effects of light, gravity, humidty temperature on plants.
8. To study effect of bending on plant morphogenesis.
9. Digital modelling of plant morphogenesis.

Programme: M.Sc. (BOTANY) SEMESTER-III
Course Code: BOTC612
Course Title: Developmental Botany

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study structure and development of male and female gametophyte.
CO-2	To study detailing of stigma and style, self and interspecific incompatibility and fertilization.
CO-3	To understand the structure, type, cellularization, culuring and function of endosperm.
CO-4	To study embryo types, organogenesis and suspensor.
CO-5	Study of basics of polyembryony, apomixis, seed growth and development.
CO-6	To study role of embryology in plant taxonomy.
CO-7	To explore haploid production, culturing of nucellus, ovule, seed and ovary.

Unit-I

Pollination and Fertilization: Ultrastructure and development of male and female gametophytes. Ultrastructural and histochemical details of style and stigma, sexualincompatibility, pollen-pistil interaction, , role of pollen wall proteins and stigma surface proteins, barriers to fertilization, methods of over coming incompatibilities, intra-ovarian pollination, in vitro pollination. Heterospermy, differential behaviour of male gametes, discharge and movementof sperms, syngamy, double fertilization and triple fusion, post fertilization inembryo sac.

Unit-II

Embryo and Endosperm: Polarization of zygote, embryogenic types, histology and organogenesis of dicotembryos, organless (undifferentiated) embryos, differentiation of embryo, structure, cytology and function of suspensor, embryo culture for rescue of hybrid embryo. Types, ultrastructure, development, functions, storage of endosperm, endosperm culturing.

Unit-III

Polyembryonyand Apomixis: Definition, types, causes and significance of polyembryony. General account, types and Importance of apomixis, Parthenogenetic development of embryo, **Seed:** Structure, importance and dispersal mechanism, Seed appendages.

Unit-IV

Embryology & Taxonomy: Diagnostic embryological characters, Role of embryology and palynology in taxonomy.

Experimental and Applied Embryology: Haploid production, Nucellus culture, Ovule and seed culture, Ovary culture.

Books Recommended

1. Bhojwani, S.S. and Bhatnagar, S.P. (1975), The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd, Delhi.
2. Eames, A.J. (1961), Morphology of the Angiosperms. McGraw Hill Book Company Inc., New York.
3. Maheshwari, P. (1950), An Introduction to the Embryology of Angiosperms. McGraw Hill Book Company Inc., New York
4. Parihar, N.S. (1993), An Introduction to Embryophyta: Vol I – Bryophyta, Vol II – Pteridophyta, Central Book Dept. Allahabad.
5. Raghavan, V. (1997), Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
6. Raghavan, V. (2000), Developmental Biology of Flowering Plants, Springer, Netherlands
7. Richards, A.J. (1986), Plant Breeding System, George Allen and Unwin, London.
8. Shivanna, K R (2003), Pollen Biology and Biotechnology, CRC Press, Science Publisher.

9. Sinnot, E.W. (1960), Plant Morphogenesis, McGraw Hill Book Company Inc., New York

Course Outcomes:

CO-1	Students learn the methods of pollination and fertilization.
CO-2	Understanding of structure and development of microsporangium, megasporangium, embryo and endosperm, male gametophyte of angiosperms.
CO-3	Understanding of endosperms types, polyembryony, apomixis and parthenogenesis.
CO-4	Understanding the growth and development of seed.
CO-5	Realize the applications of embryology and palynology in relation to plant taxonomy.
CO-6	Applications of embryology in plant tissue culture.

Suggested Practicals

1. Study of various types of flowers parts with the help of hand sections and dissections, study of different types of placentations.
2. Study from permanent preparations: development and structure of anther, pollen, ovules, microsporogenesis, megasporogenesis, gametogenesis, embryo sac, endosperm and embryo.
3. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination.
4. Test for pollen viability using strain method.
5. Pollen germination using hanging drops, sitting drop culture and suspension culture.
6. Estimating percentage and average pollen tube length ***in vitro***.
7. Field study of several types of flowers with different pollination mechanisms (wind, insects, bird pollination)

Programme: M.Sc. (BOTANY) SEMESTER-III
Course Code: BOTC613
Course Title: Plant Molecular Biology

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	An in-depth study on structure and organization of DNA, replication process, transcription process.
CO-2	An in-depth study of recombinant DNA technology including detailed study of various cloning vectors along with their construction.
CO-3	To expose the students on the understanding of various techniques viz. PCR, DNA fingerprinting, Gene mapping and DNA sequencing for molecular studies.

Unit-I

The Law of DNA constancy: DNA replication (in Prokaryotes and Eukaryotes) and repair mechanisms, C-value paradox, DNA sequencing. Organization of transcriptional units; mechanism of transcription of prokaryotes and eukaryotes; RNA processing (capping, polyadenylation, splicing, introns and exons); ribonucleo–proteins, structure of mRNA.

Unit-II

Recombinant DNA technology, host cell restriction, restriction endonucleases, DNA ligases, topoisomerases, gyrases and methylases. Cloning strategies, selection and screening of recombinant clones, genomic DNA and cDNA libraries, biological and physical containment of recombinant DNA clones. Agarose gel electrophoresis, Southern/Northern/Western blotting.

Unit-III

Cloning vehicles, plasmids, bacteriophages, viruses, cosmids, Ti-plasmid, CaMv plasmid, construction of plasmid vectors, construction of M13 vectors and λ bacteriophagetheir use in cloning and sequencing, expression vectors, lysogenic and lytic cycles in bacteirophages.

Unit-IV

Genetic colonization of plants by ***Agrobacterium*** infection and tumour growth, Ti – plasmids, neoplastic transformation of plant cells, organization of T-DNA, nucleotide sequences of T-DNA. PCR, DNA fingerprinting by RAPDs and RFLPs.

Genomics and proteomics: Genetics and physical mapping of genes, molecular markers for transgenic plants, artificial chromosomes, high throughput sequencing, genome projects, bioinformatics, functional genomics, microarrays, protein profiling and its significance.

Books Recommended

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
5. Sambrook J & Russel D. (2001). Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.
6. Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani Publishers, Delhi
7. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.
8. Brown, T.A. (2016). Gene Cloning and DNA Analysis: An Introduction. 7th Ed. Wiley Blacwell.

Course Outcomes:

CO-1	Understanding central dogma of molecular biology (replication, transcription, and translation).
CO-2	Understand the concept of recombinant DNA Technology: Restriction endonucleases, various enzymes used in genetic engineering, cloning strategies, selection and screening of recombinant clones, cloning vehicles construction of plasmids, bacteriophages, viruses, cosmid.
CO-3	Understanding ***Agrobacterium*** mediated transformation of plants.
CO-4	Conversant with Laboratory Techniques viz. DNA isolation, agarose gel electrophoresis, PCR, Sterile plating and isolation of single colonies, DNA sequencing, spectrophotometric estimation of DNA.

SuggestedPracticals

1. Identification of the parts of bright- field microscope and demonstration of its use and care.
2. Preparation of Nutrient agar medium.
3. Isolation of single bacterial colonies from different soil samples.
4. Isolation of DNA from biological samples.
5. Spectrophotometric estimation of DNA.
6. Characterization of isolated DNA using agarose gel electrophoresis.
7. Graph and analyze agarose gel data.
8. Demonstration of PCR technique.
9. Genetic transformation of bacteria.
10. Screening and selection of transformants.
11. Demonstration of DNA sequencing technique.

Programme: M.Sc. (BOTANY) SEMESTER-III
Course Code: BOTC614
Course Title: Plant Breeding and IPR

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study the origin of major crop plants.
CO-2	To study the mechanisms of male sterility and self incompatibility.
CO-3	To study breeding methods for self and cross pollinated crops.
CO-4	To study IPR, laws and conventions related to IPR.

Unit-I

Primary and secondary centres of diversity, Introduction and domestication as methods of plant breeding. Reproductive mode in flowering plant: Vegetative reproduction, apomixis and colonal propogation: Their effects on generating and fixing genotypic variation, male sterility and self incompatibility mechanisms.

Unit-II

Sexual Reproduction and breeding systems of crop species, systems of mating in sexually reproducing species and their genetic consequences. Selection method for self (Pureline and mass) and cross pollinated (Recurrent) crops;

Hybridization in self and cross pollinated crops (pedigree and bulk population). Inbreeding depression and hybrid vigour, genetic and physiological basis of heterosis, hybrid varieties, synthetic and composite varieties and their production achivements.

Unit-III

Breeding for disease resistance, classification of resistance, mechanism and genetics of disease resistance, variability systems of pathogenic fungi, breeding disease resistant varieties; multiline varieties.

Heritability, genetic advance, correlation of characters, path analysis, multiple comparison test, discriminant function and cluster analysis.

Unit-IV

Mutations, aneuploidy and polyploidy as methods of plant improvement, interspecific and intergeneric hybrids, role of genetic engineering.

Intellectual Property Rights: (IPR/TRIPS), International Intellectual Property System; Plant Variety Protection; the regular patent systems, trade secrecy, biosafety; laws and conventions related to intellectual property rights.

Books Recommended

1. Agrawal, R.L. (1998). Fundamentals of Plant Breeding and Hybrid Seed Production. Oxford and IBM Publ. Co. Pvt. Ltd., New Delhi.
2. Allard, R. W. (1981), Principles of Plant Breeding. John Wiley & Sons, N. York.
3. Anonymous (1997). National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
4. Bhandari, M.M. (1974). Practicals in Plant Breeding. A Manual cum practical record. Oxford and IBH Publ. Co. New Delhi.
5. Chopra, F.L. (Ed.) (2001). Plant Breeding: Theory and Practice. (Reprint 1994). Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
6. Gupta SK. (2005). Practical Plant Breeding. Agribios
7. Poehlman, J.M. and Sleper, D.A. (1995). Breeding Field Crops (4th Edition) Panima Publishing Corporation, New Delhi.
8. Raghuvanshi, R.K., Chauhan, A.K.S and Sidhigui, B.A. (1995). Practical Excercises in Cytology, Genetics, Plant Breeding and Biostatistics (1st Edition). CBS Publishers and Distributors, New Delhi.
9. Roy, D. (2000). Plant Breeding-Analysis and Exploitation of Variation. Narosa Publishing Hourse, New Delhi.
10. Sharma, A.K. and Sharma A. (1999). Plant Breeding. Lecture Notes on Patents. November 1999). Technology Information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology (DST), Technology Bhavan, New Mehrouli Road, New Delhi.
11. Sharma, J.R. (1994). Principles and Practice of Plant Breeding, Tata McGraw Hill Publ. Comp. Ltd., New Delhi.
12. Singh, B.D. (2006). Plant Breeding-Principles and Methods, Kalyani Publishers, Ludhiana.
13. Singh, S. and Pawar. I.S. (2006). Genetic Bases and Methods of Plant Breeding. CBS Publishers, New Delhi.
14. Stoskopf, N.C., Tames D.T. and Chrisie B.R. (1993). Plant Breeding -Theory and Practice. West view Press, Boulder
15. Sundararaj, D.D. and Thulsidas G. (1993). Botany of Field Crops (2nd Edition), MacMillan India Ltd., New Delhi.
16. Vijendra, L.D. (1998). Plant Breeding. New Age International Publishers, New Delhi.

Course Outcomes:

CO-1	Utilization of wild plants in crop improvement.
CO-2	Understanding of various methods of plant breeding.
CO-3	Understanding the concept of Intellectual Property Rights: Laws and conventions related to intellectual property rights.

Suggested Practicals

1. Floral biology in self and cross pollinated species.
2. Selfing and crossing techniques.
3. Numerical based on probability and biostatistics
4. Maintenance of experimental records.
5. Learning techniques in hybrid seed production.
6. To study Breeders kit.
7. Studies on centres of origin of various useful crops.
8. To study Vegetative Propagation in–Potato, Onion bulb, Sugarcane, Ginger.
9. To perform exploration for determination of male sterility.
10. To perform Field exploration for determination of Dichogamy, Heterostyly and Dioecy.
11. To estimate Pollen viability and Pollen germination in ***Zea mays*** and ***Hibiscus***.

Programme: M.Sc. (BOTANY) SEMESTER-III
Course Code: BOTC615
Course Title: Plant Biochemistry

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To understand the structure and properties of water along with its biological significance.
CO-2	To describe different types of interactions and their significance in biology.
CO-3	To study various metabolic pathways in plants.
CO-4	To study the history, nomenclature and classification of enzymes.

Unit-I

Cellular Chemistry: Covalent and noncovalent interactions, hydrogen bond, electrostatic interactions, hydrophobic interactions, Van der Walls forces and their significance, structure and properties of water and its biological significance, pH and its significance, pH scale, Handerson-Haselbach equation, buffers (inorganic and organic) and their importance, structure and function of Proteins, ATP-the energy currency, phosphorylation/ dephosphorylation of proteins.

Unit-II

Metabolism of Carbohydrates: Overview of intermediary metabolism, carbohydrates and lipids of physiologic significance, glycolysis and oxidation of pyruvate, citric acid cycle, catabolism of acetyl-CoA, metabolism of glycogen, gluconeogenesis and control of the blood glucose,pentose phosphate pathway and other pathways of hexose metabolism like uronic acid fructose metabolism pathways, primary and secondary metabolism in plants, shikimic acid pathway, plant secondary metabolites: Phenols, coumarins anthraquinones, flavonoids, tannins, polyphenols,

Unit-III

Lipid Metabolism: Biosynthesis of fatty acids, oxidation of fatty acids, ketogenesis, metabolism of fatty acids, ketogenesis, metabolism of acylglycerols and sphingolipids, lipid transport and storage, cholesterol, synthesis, transport and excretion, integration of metabolism and provision of tissue fuels.

Unit-IV

Enzymology: Introduction to enzymology, history of enzymes, nomenclature and classification. Specificity of enzymes: group specificity, absolute specificity, stereochemical specificity. Mechanism of enzyme catalysis: Activation energy, Nature ofactive sites, enzyme-substrate complex, induced fit hypothesis, strain and distortion theory. Enzyme Kinetics: Michaelis-Menton Equation, Lineweaver-Burk plot. Regulation of enzyme activity and concentration: Brief account of enzyme induction and repression, covalent modification, isoenzymes and allosteric enzymes.

Books Recommended

1. Buchanan, B.B., Gruissem, W., and Jones, R.L. (2002). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland.
2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D., and Layzell, D.B. (eds) (1997). Plant Metabolism. Longman, Essex.
3. Dryer, R.L. and Lata, G.F. (1989). Experimental Biochemistry, Oxford University Press, New York.
4. Murray, R.K., Grammer, D.K., Mayes, P.A. and Rodwell V.W. (1990). Harper's Biochemistry. Prentice Hall International Inc., London.
5. Nelson, D.L. and Cox, M.M. (2000). Lehninger's Principles of Biochemistry. Worth Publishers, New York.
6. Stanley, J. (2002). Essentials of Immunology and Serology. Delmar Thomson Learning, USA.
7. Tryer, L. (1995). Biochemistry W.H. Freeman & Co., New York.
8. Westhoff, P. (1998). Molecular Plant Development: From Gene to Plant. Oxford University Press, Oxford
9. Wilson, K. and Goulding, K.H. (Eds.) (1986). A Biologists Guide to Principles and Techniques of Practical Biochemistry, Edward Arnold, London.
10. Zubay G. (1993). Biochemistry. WCB Publishers, IOWA.

Course Outcomes:

CO-1	Introduction, history, nomenclature and classification of enzymes.
CO-2	Enzyme kinetics, regulation and activation.
CO-3	Overview and significance of carbohydrate metabolism, synthesis of plant secondary metabolites.
CO-4	Biosynthesis and oxidation of fatty acids. Types and significance of lipids.

Suggested Practicals

1. Preparation of the solutions of different concentrations.
2 Preparation of the inorganic and organic buffers of different conc. and pH.
3. Preparation of the standard curve of protein and determine the protein content in unknown samples by Lowry's method.
4. Estimation of the protein content in given plant sample by Bradford's method.
5. Estimation of the carbohydrates in given plant sample by Anthrone's reagent.
6. Estimation of the carbohydrates in given plant sample by Dubois's method.
7. Estimation of the activity of enzyme catalase.
8. Estimation of the activity of enzyme peroxidase.
9. Preparation of the standard curve of proline and determine the proline content in unknown samples by Bates's method.
10. SDS-PAGE for soluble proteins extracted from the given plant material and comparison of their profile by staining with Coomassie brilliant blue.
11. Extraction of plant secondary metabolitesby maceration and soxlet extraction methods.
13. Identification of plant secondary metabolites by chromatographic techniques.

Programme: M.Sc. (BOTANY) SEMESTER-III

Course Code: BOTC616
Course Title: Applied Botany

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To learn the diverse uses of plants and plant products.
CO-2	Detailed study of food plants, forest plants, fibre plants, oil and dye yielding plants.
CO-3	To study the Physical characteristics of Indian woods, methods of seasoning and chemical treatment.
CO-4	To study about rubber plants of India and methods of extraction of raw rubber, raw resin and other products.

Unit-I

Food Plants: History and nature of food plants, cereals (***Triticum aestivum, Zea mays, Oryza sativa***) and millets (***Sorghum, Pearl millet, Ragi***) major and minor cereals, legumes and pulses, vegetables, fruits and nuts, vegetable oils and fats. Manufacture of cane sugar by-products of sugar industry, distillation of alcohol and other products with special reference to distilleries in Punjab. Food adjuncts: Spices, condiments and other flavouring agents, beverages (Alcoholic and Non-Alcoholic), fumitory andmasticatory materials; functional foods.

Unit-II

Forest Products: The rubber plants of India, extraction of raw rubber and its chemical processing for the manufacturing of rubber. Woods: Wood and Cork, physical characteristics of Indian woods, methods of seasoning and chemical treatment, fire proofing of the wood. Some important commercial woods: ***Dalbergia sisso. Shorea robusta, Tectona grandis, Cedrus deodara***, Bamboo-the 'green gold' of India.

Unit-III

Fibres: Classification of fibres, physical and chemical processes involved in the manufacuring of fibres, fibre yielding plants.

Unit-IV

Industrial Plant products: Sources of gums and resins and their classifications according to their chemical nature. Extraction of the raw resin and down the line processing for terpentine and other products. Essential oil yielding plants of India, mthods of extraction of essential oils fatty oil and waxes, tanning and dyeing materials, sources of natural dyes in India and their extraction methods, merits and de-merits of plant-based dyes. Latex-yielding products, starches and other cellulose products. Manufacturing ofpaper and board from raw plant material.recycled paper; bio-fuel producing plants.

Books Recommended

1. Ambasta S P (1994). The Useful Plants of India. (3rd Ed.). Publications & Information Directorate, New Delhi.
2. Brown H P (1989). An Elementary Manual on Indian Wood Technology (Reprinted). International Book Distributors, Dehra Dun, India.
3. Kochhar S. L. (1998). Economic Botany in the Tropics. MacMillan India Limited, Delhi.
4. Pandey B P (1984). Economic Botany (3rd Ed.). S. Chand & Company Ltd., New Delhi.
5. Shankar Gopal Joshi (2000). Medicinal Plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Trotter H (1982). The Common Commercial Timbers of India and Their Uses. The Controller of Publications, Delhi.
7. Wickens GE (2004) Economic Botany: Principles and Practices, Springer, ISBN 978-0-7923-6781-9.
8. Sammbamurty, A.V.S.S., Subrahmanyam, N.S (2008). A Text Book of Modern Economic Botany. CBS Publishers & Distributors Pvt. Ltd.
9. Vardhan, R. (2009). Economic Botany. McGraw-Hill Book Company, Inc.

Course Outcomes:

CO-1	Students gain better understanding of Food Plants: History, nature of food plants and their economic importance.
CO-2	Rubber plants of India and methods of extraction of raw rubber, raw resin and other products.
CO-3	Important commercial woods of India.
CO-4	Fibre yielding plants, essential oil yielding plants of India, their use in perfume industry, fatty oil and waxes, tanning and dyeing materials, sources of natural dyes in India.
CO-5	The opportunities for income and employment generation and able to develop the ability to think and create useful plant products.

Suggested Practicals

To study economic importance, distribution, centres of origin of following specimens:

1. Study of morphology and microchemical tests for stored food material for cereals: Wheat (***Triticum aestivum),*** Rice (***Oryza sativa),*** Maize ***(Zea mays)***
2. Study of morphology and cellulose content in fibrous plant.
   Cotton (***Gossypium sp),*** Jute (***Corchorus capsularis***), Flax (***Linum usitatissimum)***
3. Study of morphology of sugar yielding plant:

Sugarcane (***Saccharum officinarum)***

4. Study of morphology of oil yielding plants:
   Cotton seed, (***Gossypium***) Groundnut (***Arachis hypogea***), Mustard (***Brassica sp)***, Coconut (***Cocos nucifera***), Castor (***Ricinus communis)***, Soyabean (***Glycine max)*** and performing tests for oil.
5. Study of morphology and alkaloid present in spices and condiments:
   Ginger (***Zingiber officinale)***, Turmeric (***Curcuma longa)***, Coriander (***Coriandrum sativum)***, Clove (***Eugenia aromaticum***), Black Pepper (***Piper nigrum)***, Cinnamon (***Cinnamomum zeylanicum***)
6. Study of morphology and medicinal value of medicinal plants:
   Amla (***Emblica officinalis)***, Bahera (***Terminalia belerica)***, Harhar (***Terminalia chibula)***, Sarpagandha (***Rauwolfia serpentine***), Ashwagandha (***Withania somnifera***), Liquorice (***Glycyrrhiza glabra***)
7. Study of morphology and nutrition value for pulses:
   Green Gram (***Phaseolus aureus***), Black Gram (***Phaseolus mungo)***, Pigeon Pea (***Cajanas cajan)***, Kidney Bean ***(Phaseolus vulgaris)***
8. Study of morphology of plants producing fruits
   Citrus (***Citrus sp)***, Apple (***Malus pumila)***, Mango (***Mangifera indica)***, Banana (***Musa sapientum)***, Pineapple (***Ananas comosus)***, Grapevine (***Vitis sp)***
9. Study of morphology of Vegetables:
   Potato (***Solanum tuberosum***), Radish (***Rapahnus sativus***), Turnip (***Brassica rapa***)
10. Study of morphology of Beverages:
    Tea (***Thea sinensis***), Coffee (***Coffea arabica***)

Programme: M.Sc. (BOTANY) SEMESTER-IV

Course Code: BOTC621
Course Title: Plant Anatomy

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	Understand the scope & importance of plant anatomy.
CO-2	Know various tissue systems of plants.
CO-3	Understand the concept of fruit and seed anatomy.
CO-4	Performing of the techniques in anatomy.

Unit-I

The shoot and Root System: Primary structure and basic vasculature, the root-stem transition, secondary growth in stems and roots, the origin of cambium and its activity, anamalous secondary growth ***Boerhaavia*** (Dicot), ***Dracaena*** (Monocot) polycyclic vasculature, secondary meristems, origin and function, the role of pericycle, phellogen, phellem, phelloderm, distribution of sclerenchyma in leaves, stems and roots.

Nodal Anatomy: Types of nodes in dicots and monocots, the node-internode transition, formation of leaf and branch traces.

Unit-II

Histology of Wood: Growth rings, types and ultrastructure of tracheids, vessels and wood rays, longitudinal parenchyma and its arrangement, grain and texture, knots, formation of resin cavities and tyloses, anatomy and chemistry of lignification, physical and anatomical features of hard and soft woods of common trees grown in India, importance of density and weight in commercial utilization of woods.

Unit-III

Floral Anatomy: The anatomy of floral axis and the whorls, the leaf origin of carpel, evidences from anatomy of essential and accessory whorls,

Fruit and Seed Anatomy: Gross and ultrastructural surface features of the fruits and seeds, role in taxonomy, internal anatomy of dicot and monocot seeds, organ and cellular anatomy of typical monocot and dicot seeds.

Unit-IV

Laticifers and Lenticels: Types and distribution, anatomy in relation to physiological roles,

Functional Anatomy: Anatomy of leaf in relation to photosynthesis and transpiration, modification of the root stem and leaf anatomy in relation to habit and habitat with special reference to aquatics, nitrogen fixers, xerophytes parasites and mycorhizas.

Books Recommended

1. Atwell, B.J., Knedermann, P.E. and Jumbull, C.G.N. (1999). Plants in Action-Adaption in Nature: Performance in cultivation. MacMillan Education, Sydney, Australia.
2. Bewley, J.D. and Black, M. (1994). Seeds Physiology of Development and Germination. Plenum Press, New York.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2000). The Embryology of Angiosperms. 4th Edn. Vikas Publishing House, New Delhi.
4. Carlquist S (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.
5. Cutler DF (1978). Applied Plant Anatomy, Longman, United Kindom.
6. Cutter EG (1978) Plant Anatomy, Part I & II, Edward Arnold, United Kingdom.
7. Dickinson WC (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
8. Fahn, A. (1982). Plant Anatomy. 3rd Edn. Pergamon Press, Oxford.
9. Nair MNB (1998). Wood Anatomy and Major Uses of Wood, Faculty of Forestry, University of Putra Malaysia, Malaysia.
10. Leivs, P., Tucker, S.C. and Endress, P.K. (1988). Aspects of Floral Development. J. Cramer, Germany.
11. Steeves, T.A. and Sussex, I.M. (1989). Patterns in Plant development. 2nd Edn. Cambridge Univ. Press, Cambridge.

Course Outcomes:

CO-1	Students learn primary structure and basic vasculature of shoot and root system of plants.
CO-2	The types of nodes in dicots and monocots, formation of leaf and branch traces.
CO-3	Histology of wood: Growth rings, types and ultrastructure of tracheids, vessels and wood rays, importance of density and weight in commercial utilization of woods.
CO-4	Floral, fruit and seed anatomy. Anatomy of leaf in relation to photosynthesis and transpiration.

Suggested Practicals

1. Study of apical meristems with the help of dissections, whole mount preparations, sections and permanent slides.
2. Study of xylem and phloem elements using maceration, staining, light and electron. micrographs (xerophytes, hydrophytes and halophytes).
3. Study of secretory structures (nectaries and laticifers).
4. Study of leguminous roots with different types of nodules.
5. Comparative anatomy of dicot and monocot root, stem and leaf.
6. To study anomalous stem behaviour in stem (***Mirabilis jalapa., Nyctanthes, Boerhaavia diffusa, Bignonia sp., Dracaena sp.)***
7. Study of anatomical features in xerophytes e.g. (leaf of ***Nerium***. stem and leaf of ***Calotropisprocera***, phyllocladode of ***Ruscus sp.***)
8. Study of anatomical features in hydrophytes e.g. (***Nelumbo*** petiole, ***Hydrilla*** stem and leaf, ***Eichhornia crassipes*** petiole, leaf lamina, ***Typha sp.***)
9. To study anatomy of storage roots e.g. (***Raphnus sativa***, ***Beta vulgaris***)
10. To study anatomy of halophytes e.g. (***Chenopodium*** stem).
11. To study permanent tissues slides (Parenchyma, Collenchyma, Sclerenchyma, Xylem and Phloem tissues)

Programme: M.Sc. (BOTANY) SEMESTER-IV
Coure Code: BOTC622
Course Title: Structure and Metabolism of Plant Hormones

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	Introduction to the different types of plant hormones.
CO-2	Structures, biosynthesis, importance and applications of important plant hormones.
CO-3	Application and uses of plant hormones.

Unit-I

General Features of Plant Hormones, their Analysis, and Quantitation: Discovery of auxin and other hormones, characteristics of plant hormones, hormones vs plant growth regulators, hormonal responses to a physiological state, bioassays, hormone extraction, analysis, and quantitation, determination of hormone synthetic pathways, regulation of hormone levels (hormonal homeostasis).

Unit-II

Auxins: Structure of auxins, physiological roles of IAA, IAA biosynthesis in higher plants, regulation of IAA levels (IAA homeostasis), inhibitors of IAA action, other naturally occuring auxins, synthetic auxins, structural diversity in auxins, signaling in auxins.
Gibberellins: Discovery, structure of gibberellins (GAs) in higher plants, physiological roles of GAs in higher plants, terpenoid pathway, biosynthesis of GAs, regulation of GA levels in the plant, endogenous levels, why are there so many GAs, other substances with GA-like activity, natural gibberellins and synthetic gibberellins, signaling in gibberellins.
Cytokinins: Discovery, biological functions and bioassays, structure of cytokinins, occurrence of cytokinins in the cytoplasm and as components of tRNA, relative distribution of natural cytokinins among plants, synthetic cytokinins, biosynthesis in higher plants,

regulation of cytokinin levels, synthetic compounds with cytokinin-like activity, cytokinin antagonists (anticytokinins), cytokinin signaling

Unit-III

Brassinosteroids: Discovery, structure and distribution, physiological roles and bioassays, biosynthesis of brassinolide, synthesis mutants and their wild-type genes, inhibitors of brassinosteroid biosynthesis, brassinosteroid structure and biological activity, regulation of castasterone and brassinolide levels, brassinosteroids cell signaling.

Abscissic Acid: Discovery, structure and occurrence in plants and fungi, physiological roles of abscissic acid (ABA), biosynthesis of ABA, natural and synthetic forms of abscisic acid, carotenoids and/or ABA synthesis, mutants, ABA synthesis inhibitiors, regulation of ABA levels, abscisic acid cell signaling

Ethylene: Discovery as a hormone, structure, distribution, and internal concentrations, physiological roles and bioassays, natural and synthetic forms of ethylene, biosynthesis in higher plants, ethylene synthesis mutants, regulation of ethylene levels in the plant, synthetic compounds that produce ethylene, inhibitors of ethylene action, role of ethylene incell signaling.

Unit-IV

Jasmonates and other Defense-Related Compounds: Introduction, discovery, distribution, and structure of jasmonates, natural and synthetic forms of JA, physiological roles of jasmonates, biosynthesis of jasmonic acid (JA), JA synthesis mutants, JA synthesis inhibitors, regulation of endogenous levels of JA, role of jasmonates in cell signaling

Microbial Synthesis of Plant Hormones: Microbial associations with plants, infection by ***Agrobacterium***, tumor induction by Pseudomonas, microbial genes involved in IAA and CK biosynthesis, expression of bacterial genes in higher plants, biology of genetic transformation by ***A. tumefaciens***, production of plant hormones by other microorganisms.

Books Recommended

1. Buchanan, B.B., Gruissem, W., and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland.
2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D., and Layzell, D.B. (eds) (1997). Plant Metabolism. Longman, Essex.
3. Galston, A.W. (1989). Life Processes in Plants. Scientific American Library, Springer-Verlag, New York.
4. Hooykaas, P.J.J., Hall, M.A., and Libbenga, K.R. (eds) (1999). Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam.
5. Hopkins, W.G. (1995). Introduction to Plant Physiology. John Wiley & Sons, Inc., New York.
6. Lodish, H., Berk, A., Zipursky, S.l., Matsudaira, P., Baltimore, D., and Darnell, J. (2000). Molecular Cell Biology. W.H. Freeman and Company, New York.

Course Outcomes:

CO-1	Students understand general features of plant hormones, their analysis and quantitation.
CO-2	Structure, physiological role and biosynthesis of auxins, gibberellins, cytokinins in higher plants.
CO-3	Discovery, structure, distribution and physiological roles of brassinosteroids, abscissic acid and ethylene.
CO-4	Introduction, discovery, distribution and structure of jasmonates and other defense related compounds in plants.
CO-5	Understand the mechanism of action and bioassays of plant hormones and their commercial use.

Suggested Practicals

1. Study the effect of IAA on morphological and physiological parameters such as shoot length, root length, fresh weight and dry weight, moisture content of seven days old seedlings.
2. To study the effect of IBA on morphological and physiological parameters such as shoot length, root length, fresh weight and dry weight, moisture content of seven days old seedlings.
3. Study the effect of Gibberellins on morphological and physiological parameters such as shoot length, root length, fresh weight and dry weight, moisture content of seven days old seedlings.
4. Study the effect of Cytokinin on morphological parameters and physiological parameters such as shoot length, root length, fresh weight and dry weight, moisture content of seven days old seedlings.
5. Study the effect of Abscisic acid on morphological and physiological parameters such as shoot length, root length, fresh weight and dry weight, moisture content of seven days old seedlings.
6. Estimation of the catalase activity by Aebi's method of seven days old seedlings.
7. Study of antagonistic effect of cytokinin/ethrel on senescence behavior of leaves of different field crops.
8. To study the bioassay ofAuxins, gibberellins, cytokinin, ethylene, abscisic acid and brassinosteroids.
9. Study the effect of gibberellins on seed germination and stem elongation of seven day old seedlings.
10. To study the effect of Abscisic acid in opening and closing of stomata.

Programme: M.Sc. (BOTANY) SEMESTER-IV
Course Code: BOTC623
Course Title: Plant Tissue Culture and Biotechnology

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study the concepts and principles of Plant tissue culture.
CO-2	To study the techniques of sterilization.
CO-3	Learning plant regeneration under in vitro conditions: organogenesis and somatic embryogenesis.
CO-4	Culturing of reproductive structures: anther, microspores, embryos, endosperm, ovule and ovary cultures, haploid production.
CO-5	Protoplast isolation, culture and protoplast fusion applications. Somaclonal variationapplications.
CO-6	Learning methods to conserve germplasm ***invitro***. Production of Secondary metabolites production through cell culture.

Unit-I

Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids, History of plant cell culture, Culture media types, Media composition, Plant growth regulators, Gelling agents, Cellular totipotency, Dedifferention and Redifferentiation, Callus and cell culture, Organogenesis and embryogenesis.

Unit-II

Micropropagation methods, stages of micropropagation, types, applications and limitations. Somatic embryogenesis types, protocol, media requirements, embryogenic callus, Embryogenic determined cells (EDCs), advantages and disadvantages of somatic embryogenesis. Applications of propagation techniques in crop improvement. Acclimatization of micropropagated plantlets, Technical problems in PTC. Axillary bud, shoot tip and meristem culture. Embryo culture technique and rescuing hybrid embryos.

Unit-III

Production of synthetic seed and their applications. Virus free plant production by PTC. Anther and microspore culture, Development of haploid plants, diploidization, applications. Protoplast isolation, culture and fusion, Somatic hybridization, Methods of somatic cell fusion, selection of somatic hybrids, cybrids and their applications. Somaclonal variations, isolation of useful variants at cellular level, Production of disease resistance, herbicide resistance and salt tolerance plants.

Unit-IV

Secondary metabolites production: Methods: Hairy Root Culture, Biotransformation, Plant Cell Immobilization and free cell suspension culture, Applications and Limitations. Production of transgenic plants, Ti plasmids***, Agrobacterium*** infection and tumour growth, ***Agrobacterium*** mediated genetic transformation of plants, Direct DNA transfer methods for genetic transformation, Crop improvement through transgenics and applications of transgenic plant production.

Books Recommended

1. Bhojwani, S.S. and Dantu, P.K. (2013), Plant Tissue Culture: An introductory text, Springer Publications.
2. Bhojwani, S.S. and Razdan, M. K. (1996), Plant Tissue Culture: Theory and Practice, a Revised Edition. Elsevier, a division of Reed Elsevier India Private Limited.
3. George, F.E., Hall, M., Klerk, G.J. (2008), Plant propagation by Tissue culture 3rd edition Vol I, Springer Publications.
4. Gupta P.K., (1990), An Introduction to Biotechnology, Rastogi Publications, Meerut.
5. Kung, Shain - Dow and Arntzen, C.J., (1989), Plant Biotechnology, ButterWorths, London.
6. Old, R.W. and Primrose S.B. (1991). Principles of Gene Manipulation, An Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.
7. Reinert, J. and Bajaj, Y.P.S., (1977), Applied and Fundamental Aspects of Plant Cell,
8. Street, H. E. (1977), Plant tissue and cell culture. University of California Press, Berkeley.

Course Outcomes:

CO-1	Know about equipment's required in tissue culture laboratory.

CO-2	Media preparation techniques for different plants.
CO-3	Sterilization techniques.
CO-4	Explant Culture -Antherculture, Pollen culture, Micropropagation. Embryo rescue technique.
CO-5	Learning the techniques of protoplasts isolation, protoplast fusion and somaclonalvariation.
CO-6	Tissue culture of important horticultural and medicinal plants.
CO-7	To apply the basic knowledge of plant tissue culture in various fields for conservation, medicine, product development, disease resistance.

Suggested Practicals

1.To study the functions and operations of various instruments used in PTC like Laminar Air Flow, Autoclave, incubators, oven, Distilllation unit, Weighing balance, pH meter etc.

2. Laboratory design set up of PTC lab.

3. Sterilisation techniques.

4. Different types of Enclosures used in PTC.

5. Preparation of stock solutions and media preparation.

6. Selection, preparation and inoculation of explant.

7. Synthetic Seed Production.

8. Micropropagation and its different steps.

9. Significance of growth hormones in culture.

10. Induction of callus from different explants.

11. Anther culture and ovary culture.

Programme: M.Sc. (BOTANY) SEMESTER-IV
Course Code: BOTC624
Course Title: Analytical Techniques

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	Detailed study of primary objectives is to develop the skills to understand the theory and practice of analytical techniques.
CO-2	To understand theoretical aspects of key analytical techniques and instruments used in plant sciences including microscopy, X-ray diffraction, Chromatographaic and spectroscopic techniques.
CO-3	To study Principles and applications of techniques of nucleic acid.
CO-4	To provide scientific understanding of analytical techniques and detail interpretation of results.

Unit-I

Microscopic techniques: Principles and application of light, phase contrast, fluorescence scanning and transmission electron microscopy, cytophotometry and flow cytometry, Overview of fixation and staining.

Unit-II

Principles and applications of gel filteration, ion-exchange, coloumnthin layer and gas chromatography, high pressure liquid (HPLC) chromatography, electrophoresis, centrifugation techniques.

Unit-III

Principles of biophysical methods used for analysis of biomolecules, X-ray diffraction, UV/CD, visible, NMR and ESR spectroscopy, hydrodynamic methods, Atomic absorption and plasma emission spectroscopy.

Unit-IV

Principles and techniques of nucleic acid: hybridisation and Cot curves; Sequencing of proteins and nucleic acids; Southern, Northern and Southwestern blotting techniques; Polymerase chain reaction.

Books Recommended

1. Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.
2. Principles of Electroanalytical Methods. John Wiley and Sons Ltd., Chichester, England.
3. Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.
4. Sheehan, D. (2000). Physical Biochemistry: Principles and Applications, John Wiley and Sons Ltd., Chichester, England.
5. Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani Publishers, Delhi
6. Wilson K. and Walker J. (Eds.) (2012). Practical Biochemistry: Principles and Techniques, Cambridge University Press, U.K. Riley, T. and Tomilson, C. (1987).

Course Outcomes:

CO-1	Principles, types and applications of microscopy.
CO-2	Role of fixation and staining in slide preparation.
CO-3	Principles, types and applications of chromatographic techniques.
CO-4	Role and types of spectroscopic techniques in chemical structure establishment in natural chemistry.
CO-5	Principles and techniques of biomolecules and plants ***i.e.*** DNA, proteins, lipids.

Suggested Practicals

Experiments based on following techniques:

1. Paper Chromatographgy
2. Thin Layer chromatography
3. Column chromatography
4. Gel Filtration Chromatography
5. Ion Exchange Chromatography
6. Affinity Chromatography
7. Electrophoresis: PAGE and SDS-PAGE
8. UV-Vis Chromatography
9. Demonstration of PCR
10. Centrifugation
11. Flourescent Microscopy

Programme: M.Sc. (BOTANY) SEMESTER-IV

Course Code: BOT C625
Course Title: Diversity and Biology of Angiosperms

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To study the history of plant classification and major classification system.
CO-2	Study of plant nomenclature, IUCN and Important herbaria of World.
CO-3	To study origin of angiosperms.
CO-4	Role of chemotaxonomy, cytotaxonomy, numerical taxonomy, anatomy, palynology and embryology in plant taxonomy.
CO-5	Preparation of botanical keys at generic level by locating key characters.
CO-6	Knowledge of various medicinal plant species.
CO-7	Knowledge of secondary metabolites and its use in taxonomy.

Unit-I

Historical perspective of plant classification, Salient features of various systems of classification (Bentham & Hooker, Engler and Prantl, Cronquist, Takhtajan, Hutchinson). Brief reference of Angiosperm PhylogenyGroup (APG) classification. Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority; Names of hybrids. IUCN, Red data book.

Unit-II

Origin of angiosperms, A brief account on origin and phylogeny of angiospermsthe nature of prabableancestors of angiosperms with different theories. Plant molecular systematics, numerical taxonomy and serotaxonomy, palynology and embryology in relation totaxonomy.

Unit-III

Biosystematic approach to taxonomy Characters; Variations; OTUs, character weighting and coding; cluster analysis; Phenograms, cladograms, phylogenetic trees. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys.

Unit-IV

Concepts of phytogeography and its relevance, phytogeographic regions of the world and India, factors determining vegetational types. Endemism, hotspots, plant explorations, invasions and introductions, localplant diversity and its socio-economic importance.

Books Recommended

1. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Cole, A.J. (1969). Numerical Taxonomy, Academic Press, London
3. Cracknell, A.P, Hayes, L. (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition)
4. Crawford, D.J. (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK. Brown, H.P. (1989). An Elementary Manual of Indian Tree Technology, Dehradun.
5. Davis, P.H. and Heywood, V.H. (1973). Principles of Angiosperms Taxonomy. Robert E. Kreiger Pub. Co., New York.
6. Judd, W.S, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002) Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
7. Naik, V. N. (1992). Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Limited, New Delhi.
8. Nei, M. and Kumar, S. (2000) Molecular Evolution and Phylogenetics. Oxford University Press, New York.
9. Semple, C. and Steel, M.A. (2003) Phylogenetics. Oxford University Press, Oxford.
10. Sympson, M.G. (2006). Plant Systematics. Amsterdam Elsevier/Academic Press.
11. Sharma, O.P. (2005). Plant Taxonomy. Tata McGraw-Hill Publishing Company Limited, New Delhi
12. Singh G. (2004). Plant Systematics: Theory and Practice. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Course Outcomes:

CO-1	Study plant morphology.
CO-2	Description of a plant specimen.
CO-3	Studyof locally available families of flowering plants.
CO-4	Identification of genus and species of locally available wild plants.
CO-5	Preparation of botanical keys at generic level by locating key characters.
CO-6	Knowledge of various medicinal plants pecies.
CO-7	Knowledge of secondary metabolites and its use in taxonomy.

Suggested Practicals

1. Description of specimen from representatives. Locally available families. This list is indicative only
    - Ranunculaceae: ***Ranunculus, Delphinium***
    - Brassicaceae: ***Brassica, Iberis***
    - Malvaceae: ***Hibiscus***
    - Rutaceae: ***Murraya, Citrus***
    - Fabaceae: ***Lathyrus, Cassia, Acacia, Mimosa***
    - Rosaceae: ***Rosa, Prunus***
    - Asteraceae: ***Helianthus, Ageratum, Sonchus***
    - Apiaceae: ***Coriandrum, Foeniculum***
    - Apocynaceae: ***Vinca, Nerium, Thevetia***, ***Calatropis***
    - Solanaceae: ***Petunia, Solanum, Datura***
    - Euphorbiaceae: ***Euphorbia, Phyllanthus***
    - Lamiaceae: ***Ocimum, Salvia***
    - Chenopodiaceae: ***Chenopodium***
    - Liliaceae: ***Asparagus, Asphodelus***
    - Poaceae: ***Triticum, Avena***
2. Location of key character and use of keys at family level.
3. Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated.
4. Training in using flora and herbaria for identification of specimens described in the class.

Programme: M.Sc. (BOTANY) SEMESTER-IV
Course Code: BOTC724
Course Title: Hazardous Chemicals
(Optional Paper)

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	To know the impact of hazardous chemicals on human health.
CO-2	To study different categories of hazardous chemicals and their characteristics.
CO-3	To study the risk assessment of the hazardous chemicals and defining their toxicity.
CO-4	Transportation and storageof hazardous chemicals in a safe way.

Unit-I

Physical Properties of Chemicals: Vapour pressure, vapour density, solubility, octanol/ water partition coefficient, odour.

Toxic Properties: Absorption and excretion, detoxification and bioactivation, common terms used for toxicology.

Target Organs: Injury to liver, kidney, immune system, respiratory tract, skin, eyes, nervous system, cardiovascular system, carcinogens and teratogens.

Combustible and Explosive Properties: Flashpoint and autoignition temperature of some chemicals, explosive characteristics of chemical substances.

Unit-II

Chemical Warfare Agents: Hazardous properties, types of chemical agents in warfare, antidotes and decontamination

Aldehydes: Formaldehyde, Acrolein.

Alkaloids: Nicotine, Morphine, Heroin, LSD, Cinchonine.

Amines: Ethylenimine, aniline, benzidine, O-toluidine, Phenylhydrazine.

Azodyes: Acid Yellow 3, Sudan orange, acid red 18, acid blue-9, acid green-3.

Chlorohydrins: Ethylene chlorohydrin.

Nitriles: Acrylonitrile, acetonitrile.
Cyanides: Hydrogen cyanide, Sodium cyanide, potassium cyanide, cyanogen.
Organic Isocyanates: Methyl isocyanate.

Unit-III

Dioxins: 2,3,7,8- Tetrachlordibenzo-p-dioxin (TCDD).
Epoxy Compounds: Ethylene oxide, propylene oxide
Halogenated Hydrocarbons: Chloroform, carbon tetrachloride, dichlorobenzene.
Aromatic Hydrocarbons: Benzene, xylene.
Polynuclear Aromatics: Benzo-α- pyrene, Benzo-α-anthracene. **Toxic Gases:** Arsine, mustard gas, phosgene.
Explosives: Nitroexplosives-Nitroglycerine, dynamite, nitrocellulose, 2,4,6 - trinitrotoluene, picric acid.

Unit-IV

Pesticides: Structure, LD_{50}/ LC_{50} , health hazards and exposure limit of following pesticides:
Carbamates: Aldicarb, Carbaryl, Carbofuran, Methiocarb, Mexacarbate
Organochlorines: Aldrin, Dieldrin, Endrin, Heptachlor, Chloradane, Endsulphan, DDT, Methoxychlor, Lindane.
Organophosporus Pesticides: Parathion, Dichrotophos, Monocrotophos, Chloropyriphos.
Herbicides: 2,4-D, 2,4,5-T, Silvex, Atrazine, Metribuzin, Monuron, Diuron, Paraquat, Tribunil, Alachlor

Book Recommeded

1. Patnaik, P. (2007). A Comprehensive Guide to the Hazardous Properties of Chemical Substances. 3rd Ed., Wiley, New York.
2. Mumford, C.J., Carson, P.A. (2002) Hazardous Chemicals Handbook, 2nd Ed., Butterworth-Heinemann, Elsevier, Netherlands.
3. Sr. Lewis, R.J. (2008). Hazardous Chemicals Desk Reference, 6th Ed., Wiley-Interscience.

Course Outcomes:

CO-1	Students will be able to identify and differentiate hazardous and non-hazardous chemicals.
CO-2	Physical and toxic properties of hazardous chemicals.
CO-3	Detail studies of some major hazardous chemical and their mechanism of action.
CO-4	Structure, LD_{50} and health hazards of pesticides and herbicides.
CO-5	Understand the procedures for safe and proper disposal of chemicals.

Programme: M.Sc. (BOTANY) SEMESTER-IV
Course Code: BOTC725
Course Title: Immunology
(Optional Paper)

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 37; Int. Ass.: 13**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections. Each unit of the syllabus should be given equal weightage of marks.
Section A (7 Marks): It will consist of seven parts with equal distribution from the whole syllabus. Candidates will be required to attempt all the parts, carrying one mark each. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Course Objectives:

CO-1	Basic knowledge of immunological processes at a cellular and molecular level
CO-2	Central immunological principles and concepts.
CO-3	Mechanisms and cellular players of innate and adaptive immunity and how they relate.
CO-4	Principles governing vaccination and the mechanisms of protection against infectious diseases.
CO-5	Basics of immunological tolerance, autoimmunity, transplantation, allergy & allergic diseases.
CO-6	Immune system in cancer; tumor immunology and principles of immunotherapy.

Unit-I

An Overview of the Immune System: Historical perspective, an introduction to the immune system – innate and adaptive immunity. Immunodeficiencies: secondary immunodeficiency disorders, immune system in Health & Disease, specially AIDS.

Unit-II

Antigens and Antigen Recognition: Antigens: prerequisites for immunogenicity, relative immunogenicity of different types of molecules, Molecules that enhance immunogenicity. Activators of lymphocytes: antigens, superantigens, mitogens. Antigen recognition by cells of innate immunity & adaptive immunity.

Unit-III

Antibodies: Gamma globulins; structure, bifunctional property of antibodies, determining bifunctionality, cross reactivity, Antigen antibody interactions: primary interactions, secondary interactions. Classification of antibodies: Isotypes, Allotypes, properties & biological functions of antibody isotypes, IgG, IgE, IgM, IgD, IgA, Monoclonal antibodies

Unit-IV

Cells and Tissues of Immunity: Lymphoid tissues: primary & secondary lymphoid tissues, cells of innate immunity: phagocytes, antigen presenting cells, natural killer cells, Eosinophils, mast cells and basophil, B- cells, secondary immune responses. The major histocompatibility complex, antigen process and antigen presentation, complement.

Books Recommended

1. Goldsby, R.A. Kindt, T.J., Oxborne B.A., Kuby, J. (2003). Immunology.W.H. Freemen & Company, NewYork.
2. Stanley, J. (2002). Essentials of Immunology and Serology. Delmar Thomson Learning, USA.

Course Outcomes:

CO-1	Students will learn the basic concepts of immunology and its relation to human health.
CO-2	Conceptual understanding of the subject for successful use of immunology in future careers in research, teaching and industry.
CO-3	Understanding of immune system against invading pathogens.