KHALSA COLLEGE AMRITSAR

(AN AUTONOMOUS COLLEGE)

POST GRADUATE DEPARTMENT OF BOTANY

SYLLABUS: BOTANY
SESSION 2024-26

Khalsa College Amritsar

An Autonomous College

SYLLABUS

M.Sc. (BOTANY)
SEMESTER I-II

S.No.	PROGRAMME OBJECTIVES
1.	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.
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.	To develop a thirst amongst the students to preserve the natural resources and environment.
5.	To enable the graduate prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

S.No.	PROGRAMME SPECIFIC OUTCOMES (PSOS)
PSO-1	Formulate the ideas, draft scientific reports, authenticate conclusions, and present information 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 filed visits etc.

M. Sc. Botany
Programme: MBOT
Scheme of Courses
Session 2024-2026

COURSE SCHEME											
SEMESTER – I											
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
BOTC411	Phycology	3	2	1	0	3	56	-	19	75	5-6
BOTC412	Mycology and Plant Pathology	3	2	1	0	3	56	-	19	75	7-9
BOTC413	Genetics and Evolution	3	2	1	0	3	56	-	19	75	10-11
BOTC414	Plant Physiology	3	2	1	0	3	56	-	19	75	12-13
BOTC415	General Microbiology	3	2	1	0	3	56	-	19	75	14-15
BOTC416	Introduction to Computers and Basic Bioinformatics	3	2	1	0	3	56	-	19	75	16-17
BOTC417	Botany Practical I (Based on BOTC411, BOTC412 & BOTC413)	2+2+2	0	0	3	3	-	56	19	75	18-19
BOTC418	Botany Practical II (Based on BOTC414, BOTC415 & BOTC416)	2+2+2	0	0	3	3	-	56	19	75	20-21
		30				**24**				**600**	

For practical one credit hour means two hours for practical/per week; IA = Internal assessment

M. Sc. Botany
Programme: MBOT
Scheme of Courses
Session 2024-2026

SEMESTER – II											
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
BOT C-421	Bryology	3	2	1	0	3	56	-	19	75	22-23
BOT C-422	Diversity and Biology of Gymnosperms	3	2	1	0	3	56	-	19	75	24-25
BOT C-423	Cell Biology	3	2	1	0	3	56	-	19	75	26-27
BOT C-424	Pteridology	3	2	1	0	3	56	-	19	75	28-29
BOT C-425	Ecological Modelling and Forest Ecology	3	2	1	0	3	56	-	19	75	30-32
BOT C-426	Theoretical Biology	3	2	1	0	3	56	-	19	75	33-34
BOT C-427	Botany Practical I (Based on BOTC421, BOTC422 & BOTC423)	2+2+2	0	0	3	3	-	56	19	75	35-36
BOT C-428	Botany Practical II (Based on BOTC424, BOTC425 & BOTC426)	2+2+2	0	0	3	3	-	56	19	75	37-38
BOT C-429	On Job Training or Assignment	2	0	0	1*		**Satisfactory not Satisfactory**			-	-
		32				**24**				**600**	

***Noncredited, For practical one credit hour means two hours for practical/per week; IA = Internal assessment**

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC411
Course Title: Phycology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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

Classification of algae, important system of algal classification (Fritsch F.E., 1945 and Robert E. Lee, 2008). General characteristics and history of algae, Habitat and habit of algae, algal flagella, algal nutrition, Organization of thallus, structure of algal cell, algal pigments and photosynthetic apparatus.

Unit-II

Origin and evolution of sex organs in algae, Comparative account of life history patterns, food reserves and reproduction in algae.

Cyanophyta - ***Nostoc, Oscillitoria, Rivularia, Spirulina.***

Unit-III

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

Xanthophyta-***Vaucheria***

Phaeophyta - ***Ectocarpus, Laminaria, Dictyota, Fucus.***

Unit-IV

Rhodophyta –***Polysiphonia***, ***Batrachospermum*** and ***Porphyra.*** Rhythms and bioluminescence in Dino-flagellates, 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 life cycle pattern of algae.
CO-3	To understand the phenomenon of algal blooms and bioluminescence.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC412
Course Title: Mycology and Plant Pathology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

Course Objectives:

CO-1	Students will get insight on general characteristics, life cycle, 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, mycological studies in india, general characteristics of fungi and fungi like organism, somatic structures and hyphal forms and modification of hyphae, modes of reproduction, life cycle patterns, growth and differentiation, fungal nutrition-modes and mechanism of 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

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 upto generic level.
CO-2	Recognization of the morphology, anatomy, physiology, reproduction, life cycle 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.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC413
Course Title: Genetics and Evolution

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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 regulation 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 structures of gene and "Complex loci" in eukaryotes, 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. Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment.

Unit-II

Genetic regulation of cell cycle: Homologous chromosomes, polytene and lampbrush chromosomes, Oncogenes, biochemistry and molecular biology of cancer, genetic disorders, 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 Elementsin Prokaryotes and Eukaryotes: Ac-Ds in Maize, Copia and P elements in***Drosophila*** and Ty elements of yeast.Significance of transposable elements.

Transcription (Prokaryotes and Eukaryotes) Types and structure of RNA (mRNA, tRNA, rRNA) RNA polymerase types; Translation in Prokaryotes and Eukaryotes.

Regulation of Gene Expression in Prokaryotes (lac operon and trp operon) and Eukaryotes (Methylation, hormonal control, Britten-Davidson's model)

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. Brown, T.A. (2017). Genomes 4, 4th edition, Garland Science, United States.
3. Gardner, E.J. Simons, M.J. and Snustad, D.P. (2006). Principles of Genetics, John Wiley & Sons, Inc., New York, Toronto.
4. Griffiths, A. J., Wessler, S. R., Lewontin, R. C., Gelbart, W. M., Suzuki, D. T., & Miller, J. H. (2005). An introduction to genetic analysis. Macmillan. Freeman and Company, USA.
5. Hawley R.S. and Walker, M. Y. (2003) Advanced Genetic Analysis-Finding meaning in Genome. Blackwell Publishing, USA. 6. Klug and Cummings.(1997). Concepts of Genetics, Prentice Hall International Inc., New Jersey.
7. Khush.G.S. (1973). Cytogenetics of Aneuploids, Academic Press, New York.
8. Lewin, B. (1997) Genes VI. Oxford University Press, Oxford.
9. Martz C.P. T. and Yong, W.J. (1988).Cytogenetics.Rekha Printers, New Delhi.
10. MinKoff, E.C. (1983). Evolutionary Biology. Addison-Wesley Publishing Co., Massachussettes.
11. Schulz -Schaeffer, J., (1980).Cytogenetics of Plants, Animals and Human, SpringerVerlag, New York.
12. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons.
13. Smith, J.M. (1998). Evolutionary Genetics.2nd edition, Oxford University Press.
14. Strickberger, M.W. (2015). Genetics. 3rd Ed. Pearson Education India.15. Verma, P.S. and Aggarwal, V.K. (2014). Cell Biology, Genetics, Molecular Biology, Evolution & Ecology, S.Chand& Co. Ltd., New Delhi.

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.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC414
Course Title: Plant Physiology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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

Plants and Water, Properties of water: soil-plant-water relationships, kinetic theory, chemical and potential gradients, rate of diffusion, free energy of water, atmospheric H_2O, water potential components. Raolt's Laws

Concept of energy: Thermodynamic principles in biology, energy rich bonds, weak interactions, coupled reactions, oxidative phosphorylations, group transfers, bioenergetics.

Unit-II

Signal transduction: Overview and importnace, receptors and G-proteins, phospholipid signalling, cyclic nucleotides, calcium-calmodulin cascade, protein kinases and protein 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 atompshere and plant, Overview and enzymology of nitrogen fixation, Symbiotic and Non-symbiotic nitrogen fixation, Ammonia uptake and transport, Overview of nitrate uptake and reduction.

Unit-IV

Sulphur Metabolism: Overview of sulphate assimilation, Sulphur chemistry and function, Sulphur uptake and transport, 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, respirationand nitrogenandlipid metabolism.
CO-3	The students will able to isolate starch, pectinand various nutritive products from the plants.
CO-4	Equip students with skills and techniques related to plant physiology.

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC415
Course Title: General Microbiology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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. Bacteria Classification (Bergey's system) and their characteristics, Bacterial growth, Nutrition and Mode of reproduction (conjugation, transformation and transduction).Viruses: Origin, Nomenclature, classification, morphology and nature. Modes of transmission of plant viruses with control measures, Viroids, Modes of 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: Microbes and quality of environment Sewage treatment: Ecological Impact of raw sewage on environment and public health. Types of waste water treatment (Primary, secondary and tertiary). Analysis of total coliform bacteria and fecal coliform bacteria in drinking water, Landfills and composting. Bioremediation: Biodegradative organisms, methodology, advantages and problem associated with bioremediation.

Unit-III

Aeromicrobiology: Important airborne pathogens of plant, animal and human pathogens, 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 and 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 microscopyand 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.

M.Sc. (BOTANY) SEMESTER-I
Programme: MBOT
Course Code: BOTC416
Course Title: Introduction to Computers and Basic Bioinformatics

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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, creating a table, entering and editing, text in table, changing format of table, height width of row or coloum. Editing, deleting rows, columns in table.

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, changing chart type to 2d chart or 3d chart, linking different sheets, sorting the data, querying the data, filtering the data (auto and advance filters), what if analysis.

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, slide transition and animation: apply slide transition, animate slide content, set timing for transition and animation.

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
Human Metablome Database: HMDB
Madison Metablome Consortium Database: MMCD

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.
8. E Balagurusamy. Fundamentals of Computer, Tata McGraw-Hill Publising Company Limited, New Delhi, 2009.

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.

M.SC. BOTANY SEMESTER-I
COURSE TITLE: BOTANY PRACTICALS I
COURSE CODE: BOTC-417
(Based on BOTC411, BOTC412 & BOTC413)

Credit L-T-P. 0-0-3

Credit Hours (Per Week): 6
Maximum Marks : 56
Internal Assessment : 19
Examination Time : 3 hrs

Instructions for the paper setter: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same may be submitted for the record to COE Office, Khalsa College Amritsar.

Course Objectives:

CO-1	To Understand the diversity among Algae.
CO-2	To Know the systematic, morphology and structure, of Algae
CO-3	Students will be able to classify the fungi and the control of plant disease
CO-4	To study the mechanisms of disease development by pathogens.
CO-5	To learn about DNA, RNA and their replication, mutations, DNA repair mechanism.

Suggested Practicals

Based on **BOTC411**

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

Suggested Practicals

Based on **BOTC412**

1. 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, Apple scab).
2. To study type genus: ***Saccharomyces, Rhizopus, Mucor, Peziza, Morchella and Agaricus***.

3. Comparative biochemical and physiological observations of healthy and infected leaves.
4. Ocular micrometry of spores of pathogenic fungi.
5. Obsevations on rhizosphere of infected plants.
6. Measurement of radial growth of fungi in petri plates.
7. To collect and submit five diseased plants.

Suggested Practicals

Based on **BOTC413**

1. Learning the cytogenetics laboratory-methods of microcopy, fixation, staining and dehydration
2. To study the DNA packaging through micrographs. Polyploidy induction methods in laboratory organisms-treatment with colchicine
3. Studies on chromosomal aberrations in ***Allium cepa***-using DDT and other pesticides
4. DNA isolation, purity and quantitative estimations.
5. Demonstration of principles of genetics in ***Pisum sativum***
6. Numerical exercises on pedigree analysis, gene interactions, population genetics, chi-square and probability
7. Morphological observations in chromosomes- polytenic chromosomes of ***Drosophila melangster***.
8. Karyotypic analysis of laboratory organisms-***Allium cepa, Vicia faba, Drosophila***
9. Studies of human karyotyes and related genetic disorders.
10. Hardy-Weinberg Law and numericals based on it.

Course Outcomes:

CO-1	Understand the life cycle pattern of Algae.
CO-2	Understand the useful and harmful activities of Algae.
CO-3	Characterize different disease symptoms of crop plants.
CO-4	Identify pathogenic organisms responsible for plant diseases.
CO-5	Solving the problems related to measures of central tendency, and measures of dispersion. Studying analysing and solving the hypothetical tests like t test, chi square test.

M.SC. BOTANY SEMESTER-I
COURSE TITLE: BOTANY PRACTICALS II
COURSE CODE: BOTC-418
(Based on BOTC414, BOTC415 & BOTC416)

Credit L-T-P. 0-0-3

Credit Hours (Per Week): 6
Maximum Marks : 56
Internal Assessment : 19
Examination Time : 3 hrs

Instructions for the paper setter: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same may be submitted for the record to COE Office, Khalsa College Amritsar.

Course Objectives:

CO-1	To understand how water moves in plants at both molecular and organismal levels.
CO-2	Students will use simple laboratory skills in scientific measurements.
CO-3	Understand the importance of mineral nutrition, transpiration, photosynthesis and respiration of plant organisms.
CO-4	Know and use different number systems and the basics of programming.
CO-5	To extract information from large databases and to use this information in computer modeling.

Suggested Practicals
Based on **BOTC414**

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.

Suggested Practicals
Based on **BOTC415**

1. Acquaintance with working and principle of 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. Bacterial staining
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

Suggested Practicals

Based on **BOTC416**

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

Course Outcomes:

CO-1	Students able to understand water relation of plants with respect to various physiological processes.
CO-2	Students able to learn role of micro and macro nutrients in plant development.
CO-3	Understand mechanisms of absorption, mineral nutrition, transportation and photosynthesis in plants.
CO-4	Apply the knowledge to understand the microbial physiology and to identify the microorganisms.
CO-5	Understand and create a database using MS Access.
CO-6	Describe the features and functions of the categories of application software.

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC421
Course Title: Bryology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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, Origin of land habit, distribution and classification of Bryophytes, origin of bryophytes (including fossilrecords), primitive vs advanced/derived characters, economic and ecological importance of bryophytes.

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

Evolution of gametophyte and sporogonium in liverworts and mosses (taking examples of above mentioned orders), Spore dispersal and role of peristomial teeth in mosses.

Unit-IV

Morphogenetic changes in moss protonema and effect of various factors on protonemal differentiation and bud formation

Water Relations: Drought Tolerance; Dessication and Rehydration; Ectohydric, Endohydric and Mixohydric mosses. Diversity of Bryophytes in Punjab, Conservation of Bryophytes.

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) Puri, P. (1985). Bryophytes: A Broad Perspective. Atma Ram & Sons, Delhi.
8) Rashid, A. (1998). An Introduction to Bryophyta, Vikas Publ. House, Pvt. Ltd.
8) Goffinet, B. and Shaw, A.J.(2000). Bryophyte Biology, Cambridge University Press, Cambridge, pp. 476
10) Vanderpoorten, A. and Goffinet, B. (2009). Introduction to Bryophytes.Cambridge University Press.
11) Willis, K. and McElwain, J. (2014). The evolution of plants. Oxford University Press.

Course Outcomes:

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

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC422
Course Title: Diversity and Biology of Gymnosperms

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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

General characterstics of Gymnosperms, diversity of structure and complexity. Classification of gymnosperms and their distribution with particular reference to Indian members in time and space. Geological time scale and important geological formations in India.

Unit-II

General Account of structure, reproduction and evolutionary relationship of Progymnosperms (Aneurophytales, Archeopteridales etc.): Cycadofilicales, Glossopteridales, Pentoxylales, Cordaitales.

Unit-III

General Account of structure, reproduction and evolutionary relationship of Cycadeoidales, Cycadales, Ginkgoales, Coniferales, Taxales, Ephedrales, Welwitschiales and Gnetales.

Unit-IV

Origin and evolution of tendencies in gymnosperm and organ evolution 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.
10. Vashishta P.C., Sinha A.K. (2000) marphology of gymnosperms. S. Chand Publications.
11. Kramer, K.U. and Green, P.S. (1990). Pteridophytes and Gymnosperms, Springer

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***.

M.Sc. (BOTANY) SEMESTER-II

Programme: MBOT
Course Code: BOT C423
Course Title: Cell Biology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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

Introduction to the cell: The evolution of the cell, from molecules to first cell, from prokaryotes to eukaryotes, from single cell to multicellular organisims, levels of organization of tissues, organs and systems; comparative anatomy.

Membrane Structure and Function: Structure of model membrane, lipid bilayer, fluidity of lipid bilayer, membrane proteins, phospholipids, sphingolipids, cholesterol, glycolipids, 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, J.G. (2007) Cell and Molecular Biology. John Wiley & Sons, USA.
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.
14. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P. (2014). Molecular Biology of the Cell. 6th edition. Garland Science.
15. Buchanan, B.B., Gruissem, W. and Jones, R.L (2015). Biochemistry and molecular biology of plants. WileyPublisher; pages: 1264p

Course Outcomes:

CO-1	After successful completion of this course, students will be able to understand the concepts inProkaryotic 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.

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC424
Course Title: Pteridology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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 andmechanismof reproduction andlifecycle.
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, Stelar system in Pteridophytes.

Monophyletic vs polyphyletic origin of pteridophytes, pteridophytic life cycle with reference to alternation of generations, homologous/transformation and the antithetic/ interpolation theories of theorigin of the sporophyte.

Unit-II

General characters and classification of pteridophytes, habit, habitat, comparative organography, systematics, reproduction and types of life cycle in:

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

Abnormalities in life cycle of pteridophytes: Apomictic lifecycle, apogamy and apospory; heterospory and origin of seed habit.

Spore structure, pattern of spore germination in ferns, Fossil pteridophyta, economic importance of pteridophytes, Utility of fern for phytoremediation, speciation in ferns: role of hybridization and polyploidy

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.
8) Baker, J.G (1995). Handbook of Fern Allies. Reprint (2018). Franklins Classics.
9) Parihar, N.S. (2019). An introduction to Embryophyta Pteridophytes. Surjeet Publication.
10) Kramer, K.U. and Green, P.S. (1990). Pteridophytes and Gymnosperms,Springer

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	To understand the stelar evolution in pteridophytes.
CO-4	To understand the significance of paleobotany and its applications.

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC425
Coure Title: Ecological Modelling and Forest Ecology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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	Tostudy 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, and 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 island 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: Need and Implimentation of Environmental laws. , Water (prevention and control of pollution) Act, 1974, Air (prevention and control of pollution) Act, 1981, Environment Protection Act, 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.Applications of remote sensing in biological sciences.

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.
2. Chapman, J.L. and Reiss, M.J. (1988). Ecology: Principles and Applications, Cambridge University Press, Cambridge.
3. De, A.K. (1990). Environmental Chemistry. Wiley Eastern Pvt. Ltd., New Delhi.
4. Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment, Cambridge University Press, Cambridge.
5. Hill, M.K. (1997). Understanding Environmental Pollution. Cambridge University Press, Cambridge.
6. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.
7. Krebs, C.J. (1989 Ecological Methodology. Harper and Row, New York, USA.)
8. Koromody, E.J. (1981). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.
9. Ludwig, J and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
10. Magurran, A.E. (1988). Ecological Diversity and its Measurement. Chapman & Hall, London.
11. Mason, C.F. (1991). Biology of Freshwater Pollution, Longman.
12. Misra, R. (1968). Ecology Work Book. Oxford & IBH, New Delhi.
13. Moldan, B. and Billharz, S. (1997). Sustainability Indicators. John Wiley & Sons, New York.
14. Moore, P.W. and Chapman, S.B. (1986). Methods in Plant Ecology. Blackwell Scientific Publications, Cambridge.

15. Muller-Dombois, D. and Ellenberq, H. (1974). Aims and Methods of Vegetation Ecology, Wiley, New York.
16. Odum, E.P. (1971). Fundamentals of Ecology, Saunders , Philadelphia
17. Odum, E.P. (1983). Basic Ecology. Saunders, Philadelphia.
18. Pielou, E.C. (1984). The Interpretation of Ecological Data, Wiley, New York.
19. Poole, R.W. (1974). An Introduction to Quantitative Ecology. McGraw Hill Book Co., New York.
20. Smith, R.L. (1996). Ecology and Field Biology. Harper Collins, New York
21. Forest Ecology (3rd Edition) by James P. Kimmins Publisher Benjamin Cummings (2003)
22. Introduction of Forestry and Natural Resources (2013) by Donald L. Grebner, bettinger and Siry, Publisher Academic Press.
23. Forest Ecosystem by David A. Perry, Ram Oren and Stephan C. Hart (2nd Edition, 2008) Publisher Johns Hopkins University Press.
24. 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.

M.Sc. (BOTANY) SEMESTER-II
Programme: MBOT
Course Code: BOTC426
Course Title: Theoretical Biology

Credit L-T-P. 2-1-0

Credit Hours (Per Week): 3
Maximum Marks : 75
Theory : 56
Internal Assessment : 19

Instructions for the Paper Setters:

The question paper will be divided into 5 sections. Section A: (Total weightage 12 marks). This section will have 8 very short answer type questions and students have to attempt any 6 questions. Each question will carry 2 marks. Questions are to cover from the whole of syllabus. Section B, C, D and E: (Total weightage 44 marks). Each section will have two questions from one unit. The student will have to attempt one question from each section and question will carry 11 marks. The answers should not exceed 6 pages. The questions should not have more than two subparts.

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

MASTER OF SCIENCE IN BOTANY SEMESTER-II
COURSE TITLE: BOTANY PRACTICALS I
COURSE CODE: BOTC-427
(BASED ON BOTC421, BOTC422 & BOTC423)

Credit L-T-P. 0-0-3

Credit Hours (Per Week): 6
Maximum Marks : 56
Internal Assessment : 19
Examination Time : 3 hrs

Instructions for the paper setter: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same may be submitted for the record to COE Office, Khalsa College Amritsar.

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 and compare the main features of Cycadophyta, Ginkgophyta, Gnetophyta.
CO-4	To study and explain the origin and evolutionary significance of the pollen tube.
CO-5	To study and apply pure culture techniques in microbiology.
CO-6	Observe and measure microbial growth.

Suggested Practicals

Based on **BOTC421**

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. Field trips to familiarize with natural habitats, growth forms and diversity of bryophytes.
3. Study of Scales, rhizoids (WM) and Study of Peristome teeth (WM).
4. Study of dehiscence pattern of sporogonium.

Suggested Practicals

Based on **BOTC422**

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 dicot stem and dicot root.

Suggested Practicals

Based on **BOTC423**

1. Understanding the cytology laboratory- components of compound/electron microscope.
2. Examination of electron micrographs of eukaryotic cells with special reference to organelles.
3. Identification of different stages of mitosis using onion root meristems
4. Study of morphology of metaphase chromosomes using onion root meristem
5. Identification of different stages of meiosis from suitable plant material (Onion Buds)
6. Study of mitotic index from suitable plant material
7. Study on cyclosis in ***Tradescantia*** and ***Hydrilla*** leaves.
8. Observations on Barr bodies in Squamous epithelium.
9. Preparation of Feulgen stained chromosomes in root tip cells.
10. Effect of colchicine on chromosome movements during mitosis.
11. Use of fluorescent dye to visualise cell components.

Course Outcomes:

CO-1	Understand the morphological diversity of Bryophytes and Gymnosperms.
CO-2	Understand the economic importance and evolution of Bryophytes.
CO-3	Understand the natural habitats, growth forms and diversity of ***Cycas, Pinus, Cedrus, Ginkgo, Ephedra, Taxus, Podocarpus, Gnetum.***
CO-4	Describe the structure and functions of plant cells, tissues, and organs.
CO-5	Explain different stages of meiosis and mitosis.

MASTER OF SCIENCE IN BOTANY SEMESTER-II
COURSE TITLE: BOTANY PRACTICALS II
COURSE CODE: BOTC-428
(BASED ON BOT C424, BOT C425 & BOT C426)

Credit L-T-P. 0-0-3

Credit Hours (Per Week): 6
Maximum Marks : 56
Internal Assessment : 19
Examination Time : 3 hrs

Instructions for the paper setter: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same may be submitted for the record to COE Office, Khalsa College Amritsar.

Course Objectives:

CO-1	Students will differentiate between different stages of mitosis and meiosis.
CO-2	Students will describe the structure and function of plant cells and their organelles.
CO-3	Students will mount and prepare sections for (***Selaginella, Lycopodium, Equisetum, Ohioglossum, Pteris, Marsilea, Salvinia, and Azolla***).
CO-4	To Study habit and natural habitat of Pteridophytes.
CO-5	To study moisture content, porosity, bulk density of different soil samples.
CO-6	To solve problems related to derivatives and integrals.

Suggested Practicals

Based on **BOTC424**

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, Ohioglossum, Pteris, Marsilea, Salvinia, Azolla***).
2. To Study habit and natural habitat of Pteridophytes.
3. To Study of spore morphology in pteridophytes
4. To Study the process of spore germination on Knop's medium.

Suggested Practicals

Based on **BOTC425**

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.

Suggested Practical's

Based on **BOTC426**

1. Graph of Linear Function: $y = ax \; and \; y = ax + b$,
2. Graph Power Function: $y = ax^2$,$quadratic\ equation$.
3. Graph of Periodic Function: $Sin\theta$,$cos\theta$, $tan\theta$.
4. Graph of Exponentialfunction : $y = e^x$ and $y = a^x$
5. Graph of Logarithmic Functions: $logx$
6. Probability experiments: mutually exclusive events , independent events ,

   Standard experiment t- test

Course Outcomes:

CO-1	Relate changes of the plant body structure due to their development and as a response to various environmental factors.
CO-2	Explain morphological, reproductive and anatomical study of ***Selaginella, Lycopodium, Equisetum,Ohioglossum, Pteris, Marsilea, Salvinia, Azolla***
CO-3	Learn the techniques to determine soil moisture content, porosity, bulk density of different soil samples.
CO-4	Learn the methods of Biostatistics and its application in ecology.
CO-5	Students will be able to learn the concept of function, limit and continuity.
CO-6	Students will be able to understand the concept of matrices and determinant.