

FACULTY OF LIFE SCIENCES

SYLLABUS

Of

Botany For

Master of Science (Botany)

Semester (I – IV)

(Under Credit Based Continuous Evaluation Grading System)

Session: 2026-2027



The Heritage Institution

**KANYA MAHA VIDYALAYA
JALANDHAR
(Autonomous)**

Kanya Maha Vidyalaya, Jalandhar (Autonomous)

SCHEME AND CURRICULUM OF EXAMINATIONS OF TWO-YEAR DEGREE PROGRAMME

Master of Science (Botany) Semester-I

Session: 2026-2027

Course Code	Course Title	Course Type	Hours /Week	Credits L-T-P	Total Credits	Marks				Examination time (in Hours)
						Total	Th	P	CA	
MBTL-1071	Fungi and Plant Pathology	C	3	3-0-0	3	100	70	-	30	3
MBTL-1072	Phycology	C	3	3-0-0	3	100	70	-	30	3
MBTL-1073	Bryology	C	3	3-0-0	3	100	70	-	30	3
MBTL-1074	Plant Physiology	C	3	3-0-0	3	100	70	-	30	3
MBTL-1075	Genetics and Evolution	C	3	3-0-0	3	100	70	-	30	3
MBTL-1046	Computer Applications and Bioinformatics	IC	3	3-0-0	3	100	70	-	30	3
MBTP-1077	Botany Practicals I	C	6	0-0-3	3	100	-	70	30	6
MBTP-1078	Botany Practicals II	C	6	0-0-3	3	100	-	70	30	6
Student can opt any one of the following Interdisciplinary optional courses		IDE			4	100	70		30	3
Total					24					
IDEC-1101 IDEM-1362 IDEH-1313 IDEI-1124 IDEW-12100				Effective Communication Skills Basics of Music (Vocal) Human Rights and Constitutional Duties Basics of Computer Applications Indian Heritage: Contribution to the world (Credits of these courses will not be added to SGPA)						

Kanya Maha Vidyalaya, Jalandhar (Autonomous)

SCHEME AND CURRICULUM OF EXAMINATIONS OF TWO-YEAR DEGREE PROGRAMME

Master of Science (Botany) Semester-II

Session: 2026-2027

Course Code	Course Title	Course Type	Hours/week	Credits L-T-P	Total Credits	Marks				Examination time (in Hours)
						Total	L	P	CA	
MBTL-2071	Pteridology	C	3	3-0-0	3	100	70	-	30	3
MBTL-2072	Diversity and Biology of Gymnosperms	C	3	3-0-0	3	100	70	-	30	3
MBTL-2073	General Microbiology	C	3	3-0-0	3	100	70	-	30	3
MBTL-2074	Cell Biology	C	3	3-0-0	3	100	70	-	30	3
MBTL-2075	Ecological Modelling and Forest Ecology	C	3	3-0-0	3	100	70	-	30	3
MBTL-2336	Mathematical Biology	IC	3	3-0-0	3	100	70	-	30	3
MBTP-2077	Botany Practicals III	C	6	0-0-3	3	100	-	70	30	6
MBTP-2078	Botany Practicals IV	C	6	0-0-3	3	100	-	70	30	6
MBTI-2079	*Summer Training	C		0-0-2	2	Satisfactory/Not satisfactory				
Total					26					

* Credits/Grade point of this course will not be added in the calculation of SGPA/CGPA.

KanyaMahaVidyalaya, Jalandhar

SCHEME AND CURRICULUM OF EXAMINATIONS OF TWO-YEAR DEGREE PROGRAMME Session: 2026-2027

List of Interdisciplinary (ID) Courses

Name of ID Course	Course Code	Semester
Effective Communication Skills	IDEC-1101	I
Basic Fundamentals of Music (Vocal)	IDEM-1362	I
Human Rights and Constitutional Duties	IDEH-1313	I
Basics of Computer and IT	IDEI-1124	I
Indian Heritage: Contribution to the world	IDEW-1275	I

Kanya Mahavidyalaya, Jalandhar

SCHEME AND CURRICULUM OF EXAMINATIONS OF TWO-YEAR DEGREE PROGRAMME

Master of Science (Botany) Semester-III

Session: 2026-2027

Course Code	Course Title	Course Type			Total Credits	Marks				Examination time (in Hours)
			Hours/week	Credits L-T-P		Total	Th	P	CA	
MBTL-3071	Developmental Botany	C	3	3-0-0	3	100	70	-	30	3
MBTL-3072	Plant Molecular Biology	C	3	3-0-0	3	100	70	-	30	3
MBTL-3073	Plant Breeding and IPR	C	3	3-0-0	3	100	70	-	30	3
MBTL-3074	Plant Biochemistry	C	3	3-0-0	3	100	70	-	30	3
MBTL-3075	Applied Botany	C	3	3-0-0	3	100	70	-	30	3
MBTL-3076	Plant Morphogenesis	C	3	3-0-0	3	100	70		30	3
MBTP-3077	Botany Practicals I	C	6	0-0-3	3	100	-	70	30	6
MBTP-3078	Botany Practicals II	C	6	0-0-3	3	100	-	70	30	6
MBTI - 3079	Assignment	C	0	0-0-0	0	Satisfactory/Not satisfactory				
MBTS- 3070	Seminar	C	2	0-0-1	1	50	-	35	15	3
Student can opt any one of the following Interdisciplinary courses		IDE			4	100	70		30	3
Total					25	850				
IDEC-1101 IDEM-1362 IDEH-1313 IDEI-1124 IDEW-1275			Effective Communication Skills Basics of Music (Vocal) Human Rights and Constitutional Duties Basics of Computer Applications Indian Heritage: Contribution to the world (Credits of these courses will not be added to SGPA)							

Kanya Mahavidyalaya, Jalandhar

SCHEME AND CURRICULUM OF EXAMINATIONS OF TWO-YEAR DEGREE PROGRAMME

Master of Science (Botany) Semester -IV

Session: 2026-2027

Course Code	Course Title	Course Type	Hours/week	Credits L-T-P	Total Credits	Marks				Examination time (in Hours)	
						Total	L	P	CA		
MBTL-4071	Plant Anatomy	C	3	3-0-0	3	100	70	-	30	3	
MBTL-4072	Structure and Metabolism of Plant Hormones	C	3	3-0-0	3	100	70	-	30	3	
MBTL-4073	Plant Tissue Culture and Biotechnology	C	3	3-0-0	3	100	70	-	30	3	
MBTL-4074	Analytical Techniques	C	3	3-0-0	3	100	70	-	30	3	
MBTL-4075	Taxonomy of Angiosperms	C	3	3-0-0	3	100	70	-	30	3	
MBTL-4076 (Opt-II)	Immunology	IE	3	3-0-0	3	100	70	-	30	3	
MBTP-4077	Botany practical I	C	6	0-0-3	3	100	-	70	30	3	
MBTP-4078	Botany practical II	C	4	0-0-2	2	50	-	35	15	3	
MBTD-4079	Research Techniques/ Research Project	C	2	0-0-1	1	50	-	35	15	3	
MBTF-4070	*Field Study	C	-	0-1-0	1	Satisfactory/ Not satisfactory					
Total					25	800					

****Student can opt only one paper from the two optional papers.**

List of Optional Papers

1. MBTL-4076(I) Hazardous Chemicals
2. MBTL-4076 (II) Immunology

***Credits/Grade point of this course will not be added in the calculation of SGPA/CGPA.**

Master of Science (Botany) Semester-I (Session 2026-2027)
Program Specific Outcomes

- PSO1.** Understand the nature and basic concepts of cell biology, biochemistry, taxonomy and ecology.
- PSO2.** Analyze the relationships among animals, plants and microbes.
- PSO3.** Perform procedures as per laboratory standards in the areas of biochemistry, bioinformatics, taxonomy, economic botany and ecology.
- PSO4.** Apply the knowledge of basic science, life Science and fundamental process of plants to study and analyze any plant form.
- PSO5.** Identify the taxonomic position of plants, formulate the research literature, and analyze non reported plants with substantiated conclusions using first principles and methods of nomenclature and classification in Botany.

Semester - I

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Fungi and Plant Pathology
Course Code: MBTL-1071

Course outcomes

After passing this course the student will be able to

CO: 1 Explain diversity in the fungal kingdom

CO: 2 Understand life cycle of major genera of fungi

CO: 3 Understand the major virulence mechanisms that phytopathogens employ to colonize plants.

CO: 4 Develop an appreciation for the strategies that can be employed to incorporate disease resistance in crop plants.

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Fungi and Plant Pathology
Course Code: MBTL-1071

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

**Examination Time: 3
hrs**

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

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

• **GYMNOMYCOTA**

- (i) Acrasiomycetes - a general account
- (ii) Protosteliomycetes - a general account
- (iii) Myxomycetes: *Stemonitis*

• **MASTIGOMYCOTA** 1. Haplomastigomycotina

- (i) Chytridiomycetes: *Chytrium*, *Allomyces*; (ii) Hyphochytridiomycetes: *Rhizidiomyces*
- (iii) Plasmodiophromycetes: *Plasmodiophora*

2. Diplomastigomycotina (i) Oomycetes: *Pythium*, *Saprolegnia*, and *Achlya*

- **AMASTIGOMYCOTA** Zygomycotina (i) Zygomycetes: *Entomophthora* and *Pilobolus*
- (ii) Trichomycetes – a general account.

UNIT-II

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

AMASTIGOMYCOTA Ascomycotina (Ascomycetes)

- (i) Hemiascomycetidae: *Protomyces*
- (ii) Piectomycetidae: *Talaromyces*
- (iii) Pyrenomycetidae: *Melanospora* and *Nectria*.
- (iv) Discomycetidae: *Morchella*
- (v) Laboulbeniomycetidae: *Laboulbenia*
- (vi) Loculoascomycetidae: *Mycospharella*

Basidiomycotina (Basidiomycetes)

- (i) Teliomycetidae: *Ustilago* and *Puccinia*
 - (ii) Holobasidiomycetidae-I (Hymenomycetes): *Polyporus* and *Exobasidium*.
 - (iii) Holobasidiomycetidae-II (Gasteromycetes): *Lycoperdon*.
- (Deuteromycetes) (i) Hyphomycetidae: *Alternaria*, *Cercospora* and *Rhizoctonia*
- (ii) Blastomycetidae: *Sporobolomyces* and *Cryptococcus*.

Master of Science (Botany) Semester-I (Session 2026-2027)

UNIT-III

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

Fungal Diseases: Potato wart, damping-off diseases, Blight of colocasia, peach leaf curl, apple scab. Wilt of cotton and arhar, Anthracnose disease of chillies, Late blight of potato, Early blight of potato, Stem rust of wheat, Loose smut of wheat, Karnal bunt of wheat, powdery mildew of bajra, White rust of crucifers, Tikka disease of groundnut.

Bacterial Diseases: Bacterial leaf blight of rice, ring rot of potato, citrus canker, brown rot of potato, tundu disease of wheat.

Viral Diseases: Papaya leaf curl, leaf curl of tomato and bunchy top of banana

UNIT-IV

Principles and methods for the prevention and control for plant diseases, toxins and enzymes in plant diseases, defence mechanisms of plants against pathogens, Genetics of plant pathogen interaction.

Sex hormones in fungi, Heterothallism, heterokaryosis, parasexual cycle. Mycorrhizae in agriculture and plant growth, Biological control and concept of mycoherbicides.

Important contributions of the following mycologists/microbiologists: E. J. Butler, K.C. Mehta, B. B. Mundkur, Robert Koch, Alexander Flemming, S.A. Waksman, W.M. Stanley and Christian Gram. Important mycological and plant pathological journals and institutes.

Reference Books:

1. Agrios, G.N. (2005). Plant Pathology. 5th edition, Academic Press, New York.
2. Ainsworth, G. C. (2008). Ainsworth & Bisby's dictionary of the fungi. 10th edition, Cabi.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (2007). Introductory Mycology. 4th edition, John Wiley and sons, INC, New York.
4. Aneja, K.R. and Mehrotra, R.S. (2003). An Introduction to Mycology. 2nd edition, New Age International Private limited, New Delhi.
5. Dube, H. C. (2013). An Introduction to Fungi, 4th Edition, Scientific Publisher, India
6. Mehrotra, R.S. (2017). Plant Pathology. 3rd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Vashista, B.R., Sinha, A.K. and Kumar, A. (2016) Botany for degree students - Fungi. S. Chand and Company Ltd, New Delhi-pp 1-1002.
8. Watkinson, S. C., Boddy, L., & Money, N. (2003). *The fungi*. Academic Press.
9. Webster, J. and Weber, R. W. S. (2007). Introduction to Fungi. Cambridge University Press, Cambridge, London.

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Phycology
Course Code: MBTL-1072

Course Outcomes

After passing this course the student will be able to:

CO: 1 Identify and classify different species of algae.

CO: 2 Understand comparative life history of Green and Yellow Green Algae.

CO: 3 Provide a comparative account on Brown and Red Algae.

CO: 4 Understand the role of algae from an ecological and economic point of view.

Master of Science (Botany) Semester-I (Session 2026-2027)

Course Title: Phycology

Course Code: MBTL-1072

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Habitat and habit, Comparative account of important system of classification (Fritsch F.E.1937 and Lee R.E.2008). Organization of thallus, structure of algal cell, algal pigments and photosynthetic apparatus. Algal flagella, food reserves.

UNIT-II

Comparative account of reproductive diversity, life history patterns and nutrition. Origin & evolution of sex in algae Chlorophyta (*Volvox*, *Hydrodictyon*, *Cladophora*, *Frittschiella*, *Oedogonium*, *Zygnema*), Charophyta (*Chara*), Xanthophyta (*Vaucheria*).

UNIT-III

Comparative account of reproductive diversity, life history patterns and nutrition. Origin & evolution of sex in algae Phaeophyta (*Ectocarpus*, *Laminaria*, *Dictyota*, *Fucus*), Rhodophyta (*Porphyra*, *Batrochospermum*, *Polysiphonia*).

UNIT-IV

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

Master of Science (Botany) Semester-I (Session 2026-2027)

Reference Books:

1. Ahluwalia, A.S. (Ed.) (2003). Phycology. Daya Publishing House, New Delhi-30035
2. Anderson, R.A. (2005). Algal Culturing techniques. Physiological society of America. Elsevier Academic Press, USA.
3. Barsanti, L. and Gualtieri, P. (2014) Algae: Anatomy, Biochemistry, and Biotechnology 2nd Edition, CRC press
4. Fritsch, F.E. (1979) The structure and reproduction of algae (Vol. I and II). Vikas Publishers House Pvt. Ltd., New Delhi.
5. Kumar. H. D. (2017) Introductory Phycology, 2nd edition, East – West Press Pvt. Ltd. New Delhi.
6. Lee, R. E. (2018). Phycology. 5th edition, Cambridge University Press.
7. Vashishta, B. R., Singh, V. P. and Sinha, A. K. (2012) Botany for Degree Students – Algae S. Chand Publishing, New Delhi, India

Master of Science (Botany) Semester-I (Session 2026-2027)

Course Title: Bryology

Course Code: MBTL-1073

Course outcomes

After passing this course the student will be able to:

CO1: Understand the main characteristics of bryophyte.

CO2: Describe the distinguishing traits of liverworts, hornworts, and mosses.

CO3: Understand evolution in gametophyte and sporogonium in bryophytes.

CO4: Understand means of spore dispersal, peristome teeth and various methods to conserve bryophytes.

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Bryology
Course Code: MBTL-1073

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Habitat, habit and distribution 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 Marchantiales (*Riccia*, *Marchantia*, *Targionia*, *Cyathodium*, *Lunularia*); Sphaerocarpaceae (*Sphaerocarpus*); Calobryales, Jungermanniales (*Porella*); Metzgeriales (*Pellia*); Anthocerotales (*Anthoceros*); Sphagnales (*Sphagnum*); Andreaeales (*Andrea*); Bryales (*Funaria*)

UNIT-III

Origin of land habit, Evolution of gametophyte and sporogonium in liverworts and mosses (taking examples of above-mentioned, UNIT II).

UNIT-IV

Means of spore dispersal, peristomal teeth in mosses, palynology of Bryophytes, method to conserve Bryophytes at national level. Morphogenetic changes in moss protonema, characteristic endohydric, ectohydric, myxohydric bryophytes.

Master of Science (Botany) Semester-I (Session 2026-2027)

Reference Books:

1. Campbell, D.R. (1985). The Evolution of Land Plants (Embryophyta) Reprinted Central Book Depot, Allahabad
2. Goffinet, B. and Shaw, A.J. (2008) Bryophyte Biology, 2nd edition, Cambridge University Press, Cambridge, pp. 476
3. Willis, K. and McElwain, J. (2014). The evolution of plants. Oxford University Press.
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. Vanderpoorten, A. and Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.

Master of Science (Botany) Semester-I (Session 2026-2027)

Course Title: Plant Physiology

Course Code: MBTL-1074

Course outcomes

After passing this course the student will be able to:

CO: 1 Understand the water relationship with plants and energy metabolism.

CO: 2 Understand the interaction between the cell and signaling mechanism

CO: 3 Gain an appreciation of the nitrogen metabolism

CO: 4 Understands the sulfur chemistry and sulfur metabolism in plants

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Plant Physiology
Course Code: MBTL-1074

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Properties of water, soil-plant, water relations kinetic theory, chemical and potential gradients, Raolt's Laws, rate of diffusion free energy of water, atmospheric H₂O, 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

Photosynthesis: light absorption, emission, energy transfer, Z-scheme of photosynthesis, electron transfer, phosphorylation, CO₂ fixation, C₃, C₄, CAM Plants, Environment and its impact on photosynthesis.

Signal transduction: Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signaling mechanisms e.g. 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.

Master of Science (Botany) Semester-I (Session 2026-2027)

Reference Books:

1. Buchann, B.B., Gruissen, W., and Jones, R.L.(2010). Biochemistry and molecular biology of plants. American society of plant physiologists, Maryland. USA
2. Nobel, P.S. (2009). Physiochemical and Environmental Plant Physiology. Academic press, San Diego.U.S. A
3. Pandey, S. N. and Sinha,B. K. (2005). Plant Physiology, 4th edition, Vikas Publication House Pvt Ltd
4. Salisbury, B., Frank and Ross, W., Cleon (2004). Plants Physiology. Wadsworth, U.S.A
5. Scott, P. (2008). Physiology and Behaviour of Plants. John Wiley and Sons Ltd. England.
6. Stewart, S.and Globig, S. (2011). Plant Physiology. Apple Academic Press Inc., Canada.
7. Taiz, L., and Zeiger, E. (2010). Plant Physiology. Sinauer Associates, Inc., Publishers, Massachusetts.
8. William, G., Hopkins and Norman P.A. Huner (2008). Plant Physiology. John Wiley& Sons. Inc. USA

Master of Science (Botany) Semester-I (Session 2026-2027)

Course Title: Genetics and Evolution

Course Code: MBTL-1075

Course Outcomes

After passing this course the student will be able to

CO:1 Understand the concept of genes, genetic material and Mendelian Principles.

CO:2 Understand the biochemistry and molecular biology of cancer and mutations.

CO:3 Understand transposable genetic elements and regulation of Gene expression in prokaryotes

CO:4 Understand the role of genetic mechanisms in evolution.

Master of Science (Botany) Semester-I (Session 2026-2027)

Course Title: Genetics and Evolution

Course Code: MBTL-1075

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Fine structure of gene: classical versus molecular concept of gene, the cis-trans complementation for functional allelism; Mendelian Principles: Codominance, incomplete dominance, gene interactions, pleiotropy, penetrance, expressivity, 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 X174.

UNIT-II

Mendelian and Non-Mendelian Inheritance: Chromosome theory of inheritance; Mendelian laws; Gene interactions; Organelle inheritance.

Homologous chromosomes, polytene and Lampbrush chromosomes; Oncogenes, biochemistry and molecular biology of cancer, genetic disorders, Correlation between mutagenicity and carcinogenicity.

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.

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, attenuation.

Master of Science (Botany) Semester-I (Session 2026-2027)

UNIT-IV

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

Paleontology 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 and animals; stages in primate evolution including Homo.

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

Reference Books:

1. Brown, T.A. (2017). Genomes 4, 4th edition, Garland Science, United States.
2. 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.
3. Hawley R.S. and Walker, M. Y. (2003) Advanced Genetic Analysis-Finding meaning in Genome. Blackwell Publishing, USA.
4. Klug W. S., Cummings, M. R., Spencer, C. A. and Palladino M. A. (2030). Concepts of Genetics. 11th edition, Pearson Education, London, England.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2018). Lewin's GENES XII. Jones & Bartlett Learning. Burlington, Massachusetts.
6. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons.
7. Smith, J.M. (1998). Evolutionary Genetics. 2nd edition, Oxford University Press.
8. Watson, J. D. (2004). Molecular biology of the gene. Pearson Education India.

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Computer Applications and Bioinformatics
Course Code: MBTL-1046

Course outcomes:

A student completing this paper shall be able to:

CO: 1 Understand the concept, applications, basic and advanced skills of MS-Word.

CO: 2 Learn problem-solving skills, including the ability to develop new algorithms and analysis methods in Microsoft-Excel.

CO: 3 Understand working with MS-Powerpoint and basic concepts of Bioinformatics.

CO: 4 Demonstrate an understanding of the intersection between life and information sciences, including core concepts of structure-function relationships, gene expression, information theory, and biological database querying.

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Computer Applications and Bioinformatics
Course Code: MBTL-1046

LTP: 3-0-0

Max. Marks- 100
Theory - 70
CA – 30
Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Overview of word processing software: creating, saving and opening a new file in word processor, various formatting tools, paragraphs and sections, indents and outdents, creating 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

UNIT-II

Spreadsheet: Introduction to worksheet, worksheet basics, building a worksheet, moving within work sheet, 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

Introduction to Presentation Software: 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.

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, NCBI datamodel : why specialized data model is required for biological sequences.

UNIT-IV

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: GlycoSuiteDB, LIPIDAT.

Reference Books:

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

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Botany Practicals I
Course Code: MBTP-1077

(Based on MBTL-1071, MBTL-1072, MBTL-1073)

Course Outcomes:

After passing this course the student will be able to:

CO1: Characterize different disease symptoms of crop plants.

CO2: Identify pathogenic organisms responsible for plant diseases.

CO3: Know about the history and time-scale of land plant evolution, and evaluation of the principal types of evidence underlying.

CO4: Understand algal diversity (incl. morphology, cell structure and level of organization) to phylum level, and their association as lichens.

CO5: Understand diversity and morphology of bryophytes

CO6: Identify prominent members of bryophytes

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Botany Practicals I
Course Code: MBTP-1077

(Based on MBTL-1071, MBTL-1072, MBTL-1073)

LTP: 0-0-3

Max. Marks- 100

Practical - 70

CA – 30

Examination Time: 6 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, Kanya Maha Vidyalaya, Jalandhar.

Suggested Practicals

Based on MBTL-1071:

1. Principles & working of instruments in the Mycology & Plant Pathology laboratory.
2. Characterization of disease symptoms and identification of pathogenic organisms (stem 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, anthracnose of chillies.)
3. To study type genus *Eurotium*, *Mucor*, *Peziza*, *Geastrum*, *Nidularia*, *Lycoperdon*, *Morchella*, *Agaricus*.
4. Comparative biochemical and physiological observations of healthy and infected leaves.
5. Ocular micrometry of spores of pathogenic fungi.
6. Observations on rhizosphere of infected plants.
7. Modelling for disease forecasting.
8. Studies on different defense mechanism adopted by plants against pathogenic attack.
9. Measurement of radial growth of fungi in petriplates.

Based on MBTL-1072:

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. Preparation of synthetic media and cultivation of algae
4. Interpretation of electron micrograph of some algae.
5. Biochemical analysis of pigments present in available algal species
6. Studies on habit and habitat of various algae
7. Estimation of total carbohydrates from fresh water algae.

Based on MBTL-1073:

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 Peristomal teeth (WM).
4. Study of Scales, rhizoids (WM).
5. Study of dehiscence pattern of sporogonium.

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Botany Practicals II
Course Code: MBTP-1078

(Based on MBTL-1074, MBTL-1075, MBTL-1046)

Course outcomes:

After passing this course the student will be able to:

CO1: Prepare various biological reagents used in experiments

CO2: Estimate various biological activities in plants.

CO3: Understand the lab structure of cytogenetics and perform the molecular level of practicals like DNA isolation.

CO4: Perform the different types of cell division in various plants.

CO5: Understand basics of computer.

CO6: Interpret data in word and powerpoint files.

Master of Science (Botany) Semester-I (Session 2026-2027)
Course Title: Botany Practicals II
Course Code: MBTP-1078

(Based on MBTL-1074, MBTL-1075, MBTL-1046)

LTP: 0-0-6

Max. Marks- 100

Practical - 70

CA – 30

**Examination Time: 6
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, Kanya Maha Vidyalaya, Jalandhar.

Suggested Practicals

Based on MBTL-1074

1. Study on principles of pH meter, 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.

Based on MBTL-1075:

12. Learning the cytogenetics laboratory-methods of microscopy, fixation, staining and dehydration
13. Meiotic and mitotic studies in *Allium cepa*
14. Polyploidy induction methods in laboratory organisms-treatment with colchicine
15. Studies on chromosomal aberrations in *Allium cepa*-using DDT and other pesticides
16. DNA isolation, purity and quantitative estimations.
17. Gel Scoring and data analysis
18. Demonstration of principles of Genetics in *Pisum sativum*
19. Numerical exercises on pedigree analysis, gene interactions, population genetics, chi-square & probability
20. Morphological observations in chromosomes- study on polytenic chromosomes of *Drosophila*.

21. Karyotypic analysis of laboratory Organisms-*Allium cepa*, *Vicia faba*, *Drosophila*
22. Studies of human karyotypes and genetic diseases associated.
23. Demonstration of Hardy-Weinberg Law using pea seeds.

Based on MBTL-1046

1. Introduction to MS Word
2. Creating Table in MS Word
3. Introduction to Page Formatting
4. Printing in MS Word
5. Page Layout
6. Creating Slide Presentation in MS PowerPoint
7. Viewing the Slideshow
8. Adding Images in MS PowerPoint
9. Inserting Sound and Videos in MS PowerPoint
10. Introduction to MS Workbook
11. Creating different worksheets in MS Excel
12. Inserting Charts in MS Excel
13. Introduction to various functions in MS Excel
14. Literature Searching Using Pubmed
15. Downloading the nucleic and Protein Sequence using Biological sequence.

Semester - II

Master of Science (Botany) Semester-II (Session 2026-2027)

Course Title: Pteridology

Course Code: MBTL-2071

Course outcomes

After passing this course the student will be able to:

CO1: Understand taxonomic and biological features of Pteridophyta.

CO2: Understand systematics and life cycles of various Pteridophytes.

CO3: Comprehend the evolutionary trends among different genera of Pteridophytes

CO4: Understand land adaptations and importance of Pteridophytes.

Master of Science (Botany) Semester-II (Session 2026-2027)

Course Title: Pteridology

Course Code: MBTL-2071

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Origin of land floras, differentiation of organs in vascular plants – telome and enation theories, significance and short comings. 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 in: Psilophytales (*Psilophytum*), Rhyniales(*Rhynia*), Psilotales (*Psilotum*), Lycopodiales (*Lycopodium*), Selaginallales (*Selaginella*).

UNIT-III

Equisetales (*Equisetum*); Ophioglossales (*Ophioglossum*); Marattiales (*Marattia*); Filicales (*Pteris*, *Dryopteris*); Marsileales (*Marsilea*); Salviniiales (*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, Role of polyploidy and hybridization in speciation in ferns, Utility of ferns for phytoremediation.

Master of Science (Botany) Semester-II (Session 2026-2027)

Reference Books:

1. Parihar, N.S. (1992). The Biology and Morphology of Pteridophytes, Central Book
2. Rashid, A. (1999). An Introduction to Pteridophyta. 2nd edition, South Asia Books
3. Sporne, K.R. (1962). Morphology of Pteridophytes, BI Publications, New Delhi.
4. Stewart, W.N. (1983). Palaeobotany and Evolution of Plants. Cambridge University Press, London.
5. Vashishta, P.C. (2010). Botany: For Degree Students: Pteridophyta. 2nd edition, S Chand & Company, New Delhi, India.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Diversity and Biology of Gymnosperms
Course Code: MBTL-2072

Course outcomes

After passing this course the student will be able to:

CO1: Describe general characteristics of gymnosperms.

CO2: Understand the history of gymnosperms.

CO3: Identify and classify different gymnosperm genera and their distribution on the earth's surface.

CO4: Understand origin and evolution of gymnosperms.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Diversity and Biology of Gymnosperms
Course Code: MBTL-2072

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Gymnosperms, the first seed plants, 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, pollination mechanisms, seeds and archegonia. Cytology of Gymnosperms, general survey of the cytology of gymnosperms.

Master of Science (Botany) Semester-II (Session 2026-2027)

Reference Books:

1. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New age International, Private Limited.
2. Biswas, C. and Johri, B.M. (1997). Gymnosperms. Narosa Publishing House, New Delhi.
3. Rothwell, G.W. (1985). The Role of Comparative Morphology and Anatomy in Interpreting the Systematics of Fossil Gymnosperms, Bot. Rev., 51: 318-327.
4. Sharma, O.P. (2017). Gymnosperms. XIV edition, Pragati Prakashan, Meerut, India.
5. Sporne, K.R. The Morphology of Gymnosperms, B. I. Publications, Delhi, 1974.
6. Vashishta, P.C., Sinha, A.K. and Kumar, A. (2013). Botany for Degree Students-Gymnosperms, S. Chand & Company Ltd., New Delhi, India.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: General Microbiology
Course Code: MBTL-2073

Course outcomes

After passing this course the student will be able to:

CO1: Learn about classification, characteristics, ultrastructure of Prokaryotic and Eukaryotic microbes

CO2: Know about viruses and diseases related to viruses.

CO3: Understand the water treatment, bioremediation and aeromicrobiology

CO4: Gain knowledge on industrial products related to microbes and control of microbes

Master of Science (Botany) Semester-II (Session 2026-2027)

Course Title: General Microbiology

Course Code: MBTL-2073

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Methods in Microbiology: Basic principles of microscopy, micrometry, staining, sterilization 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.

UNIT-II

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 special reference to encephalitis, hepatitis, AIDS, rabies, foot and mouth disease.

UNIT-III

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, landfills, composting.

Bioremediation: Biodegradative organisms, advantages of bioremediations, problem associated with bioremediation, methodology of bioremediation. Aeromicrobiology.

UNIT-IV

Industrial Microbiology: The Microbe: Primary and secondary metabolites, major industrial products: foods, flavoring agents and food supplement, vitamins and beverages; organic acids; enzymes and microbial transformation; inhibitors; genetically engineered microorganisms – Human insulin and human growth hormones and vaccines.

Reference Books:

1. Atlas, R.M. (2010). *Handbook of Microbiological Media* (4th Edition). CRC Press.
2. Bauman, R.W. (2022). *Microbiology with Diseases by Taxonomy* (6th Edition). Pearson Education.
3. Black, J.G. (2021). *Microbiology: Principles and Explorations* (10th Edition). John Wiley & Sons.
4. Cappuccino, J.G. and Welsh, C.T. (2020). *Microbiology: A Laboratory Manual* (12th Edition). Pearson Education.
5. Cowan, M.K. (2024). *Microbiology: A Systems Approach* (7th Edition). McGraw Hill Education.
6. Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W.M. and Stahl, D.A. (2024). *Brock Biology of Microorganisms* (17th Edition). Pearson Education.
7. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. (2001). *Microbiology* (5th Edition). McGraw Hill Book Company.
8. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. (1986). *General Microbiology* (5th Edition). Macmillan Publishing Company.
9. Tortora, G.J., Funke, B.R. and Case, C.L. (2024). *Microbiology: An Introduction* (14th Global Edition). Pearson Education.
10. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. (2023). *Prescott's Microbiology* (12th Edition). McGraw Hill Education.

Master of Science (Botany) Semester-II (Session 2026-2027)

Course Title: Cell Biology

Course Code: MBTL-2074

Course outcomes

After passing this course the student will be able to:

CO1: Learn about levels of structural organization, cellular membranes and intracellular transport.

CO2: Gain knowledge on the structural organization and function of intracellular organelles, genes and chromosomes.

CO3: Study about the cell cycle and cell division.

CO4: Gain knowledge on cellular communication & cell signaling.

Master of Science (Botany) Semester-II (Session 2026-2027)

Course Title: Cell Biology

Course Code: MBTL-2074

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

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

Organization of Genes and Chromosomes: Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.

UNIT-III

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.

Cell Signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.

UNIT-IV

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.

Master of Science (Botany) Semester-II (Session 2026-2027)

Reference Books:

1. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M. and Walter, P. (2013). Essential cell biology. Garland Science.
2. Becker, W.M., Kleinsmith, L.J. and Hardin, J. (2000). The World of the Cell. The Benjamin/Cummings Publishing Company.
3. Clark, D. P. (2009). Molecular Biology: Academic Cell Update Edition. Academic Press.
4. Cooper, G.M. (2000). The Cell – A Molecular Approach. ASM Press, Washington, D.C.
5. Karp, G., Iwasa, J. and Marshall, W. (2019). Cell and Molecular Biology: Concepts and Experiments. 8th edition. John Wiley & Sons Inc., New York.
6. Karp, G., Iwasa, J. and Marshall, W. (2018). Karp's Cell Biology Global Edition. John Wiley & Sons Inc., New York.
7. Lodish, H., Darnell, J. E., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P. and Matsudaira, P. (2008). Molecular cell biology. Macmillan.
8. Pollard, T.D. and Ernshaw, W.C. (2002). Cell Biology. Elsevier Science (USA)

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Ecological Modelling and Forest Ecology
Course Code: MBTL-2075

Course outcomes:

After passing this course the student will be able to:

CO1: Understand the importance of Ecological models in simulating and analyzing the long-term dynamics and stability properties of complex ecological systems.

CO2: Integrate information from species association and diversity.

CO3: Understand the distribution of vegetation with respect to the environment.

CO4: Understand different Environmental Law & Policy.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Ecological Modelling and Forest Ecology
Course Code: MBTL-2075

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

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: Chisquare, 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 forest.

UNIT-IV

Environmental Law & Policy: Constitutional Provisions, Water (Prevention and Control of pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981; Environment Protection Act, 1986; Forest (Conservation) Act, 1980; Wildlife (Protection) Act, 1972; the concept of biosphere reserves, International environmental perspectives and recent amendments and emerging developments in environmental laws and policies.

Master of Science (Botany) Semester-II (Session 2026-2027)

Reference Books:

1. Barbour, M.G., Burk, J.H. and Pitts, W.D. (1998). Terrestrial Plan Ecology, 3rd edition, Benjamin/Cummings Publication Company, California.
2. Begon, M., Townsend, C. R., & Harper, J. L. (2006). Ecology: from individuals to ecosystems (No. Sirsi) i9781405111171).
3. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and Applications, 2nd edition, Cambridge University Press, Cambridge.
4. De, A.K. (1990). Environmental Chemistry. Wiley Eastern Pvt. Ltd., New Delhi.
5. Hapke, A. (2017). Forest Ecology. Callisto Reference
6. Hill, M.K. (1997). Understanding Environmental Pollution. Cambridge University Press, Cambridge.
7. Kimmins, J. P. (2004). Forest Ecology: A foundation for sustainable forest management and environmental ethics in forestry. Prentice Hall.
8. Kormondy, E.J. (1996). Concepts of Ecology. 4th edition, Prentice Hall of India Pvt. Ltd., New Delhi.
9. Schulze, E-D., Beck, E. and Müller-Hohenstein, K. (2005). Plant Ecology. Springer-Verlag Berlin Heidelberg.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Theoretical Biology
Course Code: MBTL-2336

Course outcomes

After the successful completion of this subject, the students should be able to:

CO 1: Recognize linear function, power function, periodic function, exponential function and trigonometric relation and apply differentiation and integration in real life Scenario.

CO 2: Calculate differentiation and integration of some important functions by using different rules.

CO 3: Understand the concept of random experiment and laws of probability.

CO 4: Use Correlation and Regression to identify the strength and direction of a linear relationship between the variables in real life scenario and manage to solve problems using t test, Chi- Square test and Z-test.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Mathematical Biology
Course Code: MBTL-2336

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. The question paper must contain 30% of the article/theory from the syllabus. The students can use only Non-Programmable & Non-Storage Type Calculator and statistical tables.

UNIT -I

1. Linear Function: $y=ax$ and $y=ax+b$
2. Power Function: $y=ax^n$.
3. Sine and cosine, trigonometric relations.
4. Exponential and Logarithmic Functions: Exponential function $y=aq^x$, logarithmic function.

UNIT -II

5. Differentiation and Integration: differentiation of some important functions (Linear function, Power function, Logarithmic, Exponential, Trigonometric functions), product rule and quotient rule of differentiation, chain rule of differentiation.
6. Integration: Rules of integration (Linear function, Power function, Logarithmic, Exponential, Trigonometric Functions), integration by substitution, integration of product of two functions.

UNIT -III

7. Probability: Random experiment, sample space events, mathematical definition of probability, addition and multiplication law of probability.

UNIT -IV

8. Statistics: Mean, standard deviation, Normal Distribution, Simple linear regression and correlation. ANOVA (one way and two way)
9. Hypothesis testing: Sample Statistics and parameters, standard error, Z-test, t-test as a test of single mean, chi square test as a goodness of fit and association of attributes (For uniformity, ratio and proportion)

Master of Science (Botany) Semester-II (Session 2026-2027)

Reference Books:

1. O.P Arora, V.K Bhandari, Mathematics, S.Dinesh and Co., Jalandhar city, Second edition, 2000 (Scope in Chapter-6)
2. O.P Arora, V.K Bhandair, Mathematics, S.Dinesh and Co., Jalandhar city, ninth edition, 2004 (Scope in Chapters-3,5,7,8)
3. P.N Arora, P.K Malhan, Biostatistics, Himalaya Publishing House, New Delhi, Second edition, 2013 (Scope in Chapters-5,6,8,9,10,11,12,13,14).

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Botany Practicals III
Course Code: MBTP-2077
(Based on MBTL-2071, MBTL-2072 and MBTL-2073)

Course Outcomes:

After passing this course the student will be able to:

CO1: Understand Morphological, reproductive and anatomical structures of plants.

CO2: Understand wood anatomy of gymnosperms.

CO3: Perform different experiments based on microorganisms.

CO4: Culture microorganisms on different media and their future potential.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Botany Practicals III
Course Code: MBTP-2077
(Based on MBTL-2071, MBTL-2072 and MBTL-2073)

LTP: 0-0-3

Max. Marks- 100

Practical - 70

CA – 30

Examination Time: 6 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, Kanya Maha Vidyalaya, Jalandhar.

Suggested Practicals

Based on MBTL-2071:

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*, *Dryopteris*, *Marselia*, *Salvinia*).
2. Studies on habit and natural habitat of pteridophytes.
3. Study of spore morphology.
4. Study of spore germination on Knop's medium.

Based on MBTL-2072:

1. Study of morphology, structure and reproduction in *Cycas*, *Pinus*, *Cedrus*, *Ginkgo*, *Ephedra*, *Taxus*, *Podocarpus*, *Gnetum*.
2. Study of fossils: *Williamsonia*.
3. Understanding wood anatomy using T.S, T.L.S and R.L.S in *Pinus* and *Cedrus*.
4. Study of secondary growth in stem and root.

Based on MBTL-2073:

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-sterilization, 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 microorganisms 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 Lambert Beer's law by colorimeter.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Botany Practicals IV
Course Code: MBTP-2078
(Based on MBTL-2074, MBTL-2075 and MBTL-2336)

Course Outcomes:

After passing this course the student will be able to:

CO1: Understand structures of various cell organelles.

CO2: Examine cell divisions in plant cells.

CO3: Perform different experiments based on plant ecology.

CO4: Analyze nutrients and pigment contents in plants using various techniques.

CO5: Learn application of Statistics in Life Science.

CO6: Analyze and interpret the observations statistically.

Master of Science (Botany) Semester-II (Session 2026-2027)
Course Title: Botany Practicals IV
Course Code: MBTP-2078
(Based on MBTL-2074, MBTL-2075 and MBTL-2336)

LTP: 0-0-3

Max. Marks- 100

Practical - 70

CA – 30

Examination Time: 6 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, Kanya Maha Vidyalaya, Jalandhar.

Suggested Practicals

Based on MBTL-2074:

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).
4. Calculation of Mitotic and meiotic index from dividing root tip cells and pollen grains.
5. Study on cyclosis in *Tradescantia* and *Hydrilla* leaves.
6. Observations on Barr bodies in Squamous epithelium.
7. Preparation of Feulgen stained chromosomes in root tip cells.
8. Effect of colchicine on chromosome movements during mitosis.
9. Use of fluorescent dye to visualize cell components.

Based on MBTL-2075:

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 Bray-Curtis ordination method.
4. To determine soil moisture content, porosity, bulk density of different soil samples collected from different locations.
5. To study chlorophyll content of SO₂ fumigated and unfumigated plant leaves.
6. To determine Na, K concentration of water sample using flame photometer.
7. To determine water holding capacity of different soil samples.
8. To determine percent organic Carbon and organic matter in different soil samples.
9. To estimate rate of CO₂ evolution from different soil using soda lime or alkali absorption method.

10. To determine sulphate content of water samples.
11. To determine O₂ content of water samples.

Based on MBTL-2336:

1. To Study the Exponential Growth of Microbes with the help of Graph.
2. To find the rate of change of Bacterial Growth w.r.t time, nutrient etc.
3. To Study the Application of Probability in Life Sciences / Genetics.
4. To Analyse the Biostatistical data using mean and standard deviation.
5. To Find Correlation and Regression between two Variables of Biostatistical data.
6. Application of t-test as a Single mean in Life Sciences.
7. Application of χ^2 -test as a Goodness of fit in Life Sciences.
8. Application of χ^2 - test in association of attributes in Life Sciences.
9. Application of Z- test as test of single Mean in Life Sciences in Botany.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Developmental Botany
Course Code: MBTL-3071

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 Hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

Unit-I

Pollination:

Ultrastructural and histochemical details of style and stigma, self and interspecific incompatibility, significance of pollen-pistil interaction, role of pollen pistil interaction, role of pollen wall proteins and stigma surface proteins, barriers to fertilization, methods of overcoming incompatibilities, intra-ovarian pollination, in vitro pollination.

Unit-II

Fertilization: Heterospermy, differential behaviour of male gametes, discharge, and movement of sperms, syngamy and triple fusion, post fertilization metabolic and structural changes in embryo sac.

Endosperm:

Types, ultrastructure, cellularization in nuclear endosperm, endosperm haustoria, their extension and persistence, function, storage, metabolites, endosperm culture.

Unit-III

Embryo: Polarization of zygote, embryogenic types, histology and organogenesis of dicot embryos, organelles (undifferentiated) embryos, delayed and differentiation of embryo, structure, cytology and function of suspensor, physiological and morphogenetical relationship of endosperm and embryo, embryo culture for rescue of hybrid embryo. Polyembryony: Types, genetic and somatic, pollen embryos.

Apomixis:

Apospory, Parthenogenetic Development of Embryo, Importance. Seed: Growth and Development, Seed Appendages.

Unit-IV

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

Role of Embryology in Plant Breeding:

Embryology of hybrids, disfunction of endosperm, arrested development of embryo.

Reference Books:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2015). The Embryology of Angiosperms (6th Edition). Vikas Publishing House Pvt. Ltd, Delhi.
2. Dafni, A., Hesse, M., and Pacini, E. (2012). Pollen and pollination. Springer Science & Business Media.
3. Grossniklaus, U. (2019). Plant Development and Evolution. Academic Press
4. Maheshwari, P. (1950), An Introduction to the Embryology of Angiosperms. Tata McGraw Hill Publishing Company Ltd. Bombay-New Delhi.
5. Parihar, N.S. (1993). An Introduction to Embryophyta: Vol I-Bryophyta, Vol II Pteridophyta, Central Book Dept. Allahabad.
6. Raghavan, V. (2012). Developmental Biology of Flowering Plants. Springer Science & Business Media.
7. Raghavan, V. (1997). Molecular Embryology of Flowering Plants. Cambridge University Press.
8. Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Science Publisher
9. Sinnet, E.W. (1960), Plant Morphogenesis, McGraw Hill Book Company Inc., New York.
10. Timmermans, M. C.P. (2010). Plant Development. Academic press.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Molecular Biology
Course Code: MBTL – 3072

Course outcomes:

After passing this course the student will be able to:

CO1: Gain knowledge about DNA sequencing and RNA processing.

CO2: understand different techniques related to molecular biology.

CO3: understand the structures and purposes of cloning vehicles.

CO4: gain knowledge about genetic cloning and genomics & proteomic techniques.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Molecular Biology
Course Code: MBTL – 3072

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 Hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

Unit-I

DNA Organization, Transcription and RNA Processing: -The law of DNA constancy and C-value paradox; DNA sequencing; organization of transcriptional units; mechanism of transcription in prokaryotes and eukaryotes; RNA processing including capping, polyadenylation and splicing; introns and exons; ribonucleoproteins; structure of mRNA.

Unit-II

Recombinant DNA Technology and Molecular Techniques: 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 Vectors and Expression Systems: Cloning vehicles, plasmids, bacteriophages, viruses, cosmids, Ti-plasmid, CaMv plasmid, construction of plasmid vectors, M13 vectors, their use in cloning and sequencing, expression vectors, lysogeny and lytic cycles in bacteriophages.

Unit-IV

Plant Transformation, Molecular Markers, Genomics and Proteomics: 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.

Reference Books:

1. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. (2015). The World of the Cell (8th Edition). Pearson Benjamin Cummings, San Francisco.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (1987). Cell and Molecular Biology (8th Edition). Lea & Febiger / Lippincott Williams & Wilkins, Philadelphia.
3. Hackett, P.B., Fuchs, J.A. and Messing, J.W. (1988). An Introduction to Recombinant DNA Technology: Basic Experiments in Gene Manipulation (2nd Edition). Benjamin Publishing Company.
4. Karp, G. (2019). Karp's Cell and Molecular Biology: Concepts and Experiments (9th Edition). John Wiley & Sons, Inc.
5. Green, M.R. and Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual (4th Edition). Cold Spring Harbor Laboratory Press.
6. Singh, B.D. (2024). Biotechnology: Expanding Horizons (5th Edition). MedTech Science Press / Kalyani Publishers, New Delhi.
7. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2014). Molecular Biology of the Gene (7th Edition). Cold Spring Harbor Laboratory Press / Pearson.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Breeding and IPR
Course Code: MBTL –3073

Course outcomes:

After passing this course the student will be able to:

CO1: Understand sources and types of genetic variation and explain their importance for plant improvement.

CO2: Understand historical evolution of plant breeding and different centers of origin.

CO3: Describe methods that are used in plant breeding.

CO4: Understand IPR (Intellectual property right)

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Breeding and IPR
Course Code: MBTL –3073

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 Hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

Unit-I

Genetic Resources and Breeding Systems: Primary and secondary centres of diversity, utilization of wild plants in crop improvement, introduction and domestication as methods of plant breeding. Types and introduction, vegetative sexual and apomictic, their effects on generating and fixing genotypic variation, male sterility and self-incompatibility mechanisms.

Unit-II

Breeding systems of crop species: systems of mating in sexually reproducing species and their genetic consequences. Breeding methods for self- and cross-pollinated crops; pureline and mass selection, recurrent selection and clonal selection. Hybridization in self- and cross-pollinated crops. Inbreeding depression and hybrid vigor, genetic and physiological basis of heterosis, hybrid varieties, synthetic and composite varieties.

Unit-III

Disease Resistance and Genetic Improvement in Plants: Breeding for disease resistance, classification of resistance, responses of the host to pathogens, variability systems of pathogens, breeding disease resistant varieties; multiline varieties. Heritability, genetic advance, correlation of characters.

Unit-IV

Intellectual Property Rights (IPR): Concepts and significance of Intellectual Property Rights (IPR) and the TRIPS Agreement; international intellectual property system; Plant Variety Protection (PVP); patent system; trade secrets; biosafety; and national and international laws, treaties, and conventions related to intellectual property rights.

Reference Books:

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, V.L. (Ed.) (2018). Plant Breeding: Theory and Practice. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
6. Gupta, S.K. (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. Priyadarshan, P.M. (2019). Plant Breeding: Classical to Modern. Springer Singapore
9. Raghuvanshi, R.K., Chauhan, A.K.S and Sidhigui, B.A. (1995). Practical Exercises in Cytology, Genetics, Plant Breeding and Biostatistics (1st Edition). CBS Publishers and Distributors, New Delhi.
10. Roy Darbeshwar (2000). Plant Breeding-Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.
11. 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.
12. Sharma, J.R. (1994). Principles and Practice of Plant Breeding, Tata McGraw Hill Publ. Comp. Ltd., New Delhi.
13. Singh, B.D. (2005), Plant Breeding - Principles and Methods, Kalyani Publishers, Ludhiana.
14. Singh, S. and Pawar, I.S. (2006). Genetic Bases and Methods of Plant Breeding. CBS Publishers & Distributors
15. Stoskopf, N.C., Tomes, D.T., Christie, B.R. and Christie, B. R. (2019). Plant Breeding: Theory And Practice. CRC Press.
16. Sundararaj, D.D. and Tulsidas G. (1993). Botany of Field Crops (2nd Edition), MacMillan India Ltd., New Delhi.
17. Vijendra Das L.D (1998). Plant Breeding. New Age International Publishers, New Delhi.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Biochemistry
Course Code: MBTL – 3074

Course outcomes:

After passing this course the student will be able to:

CO1: Understand cellular chemistry and interactions.

CO2: Understand the structure and metabolism of carbohydrates.

CO3: Describe structure, functions, and the metabolism of lipids.

CO4: Understand kinetics of enzyme catalysed reactions and enzyme inhibitory and regulatory processes.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Biochemistry
Course Code: MBTL – 3074

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 Hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

Unit-I

Cellular Chemistry: Covalent and non-covalent interactions, hydrogen bond, electrostatic interactions, hydrophobic interactions, Van der Waals forces and their significance, structure and properties of water and its biological significance, pH and its significance, pH scale, Henderson-Hasselbach equation, buffers (inorganic and organic) and their importance, 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.

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 of active 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.

Reference Books:

1. Bowsher, C., Steer, M., and Tobin, A. (2008). Plant biochemistry. Garland Science.
2. Buchanan, B. B., Gruissem, W. and Jones, R. L. (Eds.). (2015). Biochemistry And Molecular Biology of Plants. John Wiley & Sons.
3. Heldt, H. W. and Piechulla, B. (2010). Plant Biochemistry. Academic Press.
4. Lubert, S., Berg, J., Tymoczko, J. and Gatto, G. (2019). Biochemistry, IX Edition. Macmillan Publishers.
5. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2014). Harper's illustrated biochemistry. McGraw-hill.
6. Nelson, D. L., Lehninger, A. L., and Cox, M. M. (2017). Lehninger principles of biochemistry. VII Edition. Macmillan.
7. Voet, D., Voet, J. G., and Pratt, C. W. (2018). Principles of Biochemistry, V Edition, Global Edition. John Wiley & Sons.
8. Voet, D., Voet, J. G., and Pratt, C. W. (2016). Fundamentals of Biochemistry: Life at the Molecular Level. John Wiley & Sons.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Applied Botany
Course Code: MBTL – 3075

Course outcomes:

After passing this course the student will be able to:

CO1: Demonstrate knowledge of the value of plants in our everyday lives.

CO2: Understand commercial use of different forest products.

CO3: Describe various industrial plant products.

CO4: Understand chemical processing of different products in applied botany.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Applied Botany
Course Code: MBTL – 3075

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 Hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

Unit-I

Food Plants: History and nature of food plants, major and minor cereals, legumes and pulses, vegetables, fruits and nuts. Extraction of sugar from sugarcane. Flow diagram of the process with a critical study of the steps involved, problems faced by the sugar industry in India. By-products of sugar industry, distillation of alcohol and other products with special reference to distilleries in Punjab. Food adjuncts: Spices condiments and other flavoring agents, beverages, fumitory and masticatory materials; functional foods.

Unit-II

Forest Products: Wood & Oak. Physical characteristics of Indian woods, methods of seasoning and chemical treatment of specialized use, fireproofing of the wood. Industrial manufacturing of packing material and plywood and the classifications of plywoods according to their use. Some important commercial woods: *Dalbergia spp.*, *Shorea robusta*, *Tectona grandis*, *Cedrus deodara*, Bamboo-the 'greengold' of India.

Unit-III

Industrial Plant Products: Essential oil yielding plants of India, their use in perfumery, vegetable oils, fats and waxes, starches and other cellulose products. Manufacturing of paper and board from raw plant material. Manufacturing of crude and high-quality paper, recycled paper; bio fuel producing plants.

Fibres: Different types of fibre yielding plants, classification of fibres, physical and chemical processes involved in the manufacturing of fibre.

Unit-IV

Rubber and Latex Products: The Rubber Plants of India, latex yielding plants, Extraction of Raw Rubber and its Chemical Processing for the Manufacturing of Finished Rubber. Sources of gums and resins and their classifications according to their chemical nature. Extraction of the raw resin and down the line processing for turpentine and other products. Sources of natural dyes and tannins in India and their extraction methods, merits and limitations of plant-based dyes.

Reference Books:

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. Joshi, S. G. (2000). Medicinal Plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Kochhar, S. L. (1998). Economic Botany in the Tropics. MacMillan India Limited, Delhi.
5. Pandey, B. P. (1984). Economic Botany (3rd Ed.). S. Chand & Company Ltd., New Delhi.
6. Seidemann, J. (2005). World Spice Plants: Economic Usage, Botany, Taxonomy. Springer Science & Business Media.
7. Trotter, H. (1982). The Common Commercial Timbers of India and Their Uses. The Controller of Publications, Delhi.
8. Wickens, G.E. (2004) Economic Botany: Principles and Practices, Springer, ISBN 978-0-7923-6781-9.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Morphogenesis
Course Code: MBTL – 3076

Course outcomes:

After passing this course the student will be able to:

CO1: Learn about morphogenesis and organogenesis in plants.

CO2: Understand differentiation in plants.

CO3: Describe plant regeneration processes and tissue relationships.

CO4: Understand different factors affecting plant morphogenesis.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Plant Morphogenesis
Course Code: MBTL – 3076

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 Hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

Unit-I

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, dorsi-ventral symmetry, development of symmetry.

Differentiation: Growth and differentiation, differentiation as expressed in structure, external and internal differentiation, differentiation during ontogeny, differentiation in relation to environment, physiological differentiation, differentiation without growth.

Unit-III

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.

Reference Books:

1. Ainsworth, C. (2006). Flowering and its Manipulation, Annual Plant Reviews, Vol. 20. Blackwell Publishing, Oxford, U.K.
2. Brown, T.A. (2002). Genomes, BIOS Scientific Publishers Ltd, Oxford, UK.
3. Bhojwani, S.S. and Bhatnagar, S.P. (1975). The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd, Delhi.
4. Davies, J. (2013). Mechanisms of Morphogenesis. Academic Press.
5. Lyndon, R.F. (2012). Plant Development: The Cellular Basis (Vol. 3). Springer Science & Business Media.
6. Raghavan, V. (1997). Molecular Embryology of Flowering Plants. Cambridge University Press.
7. Raghavan, V. (2012). Developmental Biology of Flowering Plants. Springer Science & Business Media.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Botany Practicals-I
Course Code: MBTP-3077

(Based on MBTL-3071, MBTL-3072 and MBTL-3073)

Course Outcomes:

After passing this course the student will be able to:

CO1: Perform immobilization of enzymes.

CO2: Wide application of enzymes and their future potential.

CO3: Perform different experiments based on plant pollination.

CO4: Understand embryology of dicot and monocot plants.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Botany Practicals-I
Course Code: MBTP-3077
(Based on MBTL-3071, MBTL-3072 and MBTL-3073)

LTP: 0-0-6

Max. Marks- 100

Practical - 70

CA – 30

Examination Time: 6 Hrs.

Instructions for the Paper Setters: 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, Kanya Mahavidyalaya, Jalandhar.

Suggested Practical's from MBTL-3071

1. Examination of the following with the help of hand sections, dissections and prepared longitudinal, transverse section of Flowers: Transmitting tissue/canal in the stigma and style, Various types of flowers and placentation, Special types of flowers with emphasis on vasculature of androecium and gynoecium.
2. Study from permanent preparations, development and structure of anther, pollen, ovules, megasporogenesis, embryo sac, endosperm and embryo.
3. Study of microsporogenesis and gametogenesis in sections of anther.
4. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa*, *Crotolaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanum melongena*).
5. Test for pollen viability using strain and in vitro pollination. 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)

Suggested Practical's from MBTL-3072

1. Identification of the parts of bright- field microscope and demonstration of its use and care.
2. Perform basic microbiological techniques such as sterile plating and isolation of single colonies.
3. Isolation of DNA from biological samples.
4. Characterization of isolated DNA using agarose gel electrophoresis.
5. Graph and analyze agarose gel data.
6. Genetic transformation of bacteria.
7. Screening and selection of transformants.
8. Demonstration of PCR technique.
9. Spectrophotometric estimation of DNA.
10. Demonstration of DNA sequencing technique.

Suggested Practical's from MBTL-3073

1. Floral biology in self- and cross-pollinated species,
2. Selfing and crossing techniques.
3. Numerical exercises 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 in *Zea mays* and *Hibiscus*.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Botany Practicals-II
Course Code: MBTP-3078
(Based on MBTL-3074, MBTL- 3075 and MBTL-3076)

Course outcomes:

After passing this course the student will be able to:

CO1: Understand concept of gene, gene cistron relationship in prokaryotes and eukaryotes.

CO2: Understand types of DNA damage, DNA repair pathways.

CO3: Exhibit clear and concise communication of scientific data.

CO4: Understand different techniques related to molecular biology.

Master of Science (Botany) Semester-III (Session 2026-2027)
Course Title: Botany Practicals-II
Course Code: MBTP-3078
(Based on MBTL-3074, MBTL- 3075 and MBTL-3076)

LTP: 0-0-6

Max. Marks- 100

Practical - 70

CA – 30

Examination Time: 6 Hrs.

Instructions for the Paper Setters: 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, Kanya Mahavidyalaya, Jalandhar.

Suggested Practical's based on MBTL-3074

1. Preparation of the solutions of different concentrations. Preparation of the inorganic and organic buffers of different conc. and pH.
2. Preparation of the standard curve of protein and determine the protein content in unknown samples by Lowry's method.
3. Estimation of the protein content in given plant sample by Bradford's method
4. Estimation of the protein content in given plant sample by Biuret's method
5. Estimation of the carbohydrates in given plant sample Anthrone's reagent.
6. Estimation of the carbohydrates in given plant sample 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.

Suggested Practical's based on MBTL-3075

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 microscopic study of fibres: Cotton (*Gossypium* sp.), Jute (*Corchorus capsularis*), Flax (*Linum usitatissimum*) Sugar yielding plant: Sugarcane (*Saccharum officinarum*)
3. Study of morphology of oil yielding plants: Groundnut (*Arachis hypogea*), Mustard (*Brassica* sp), Coconut (*Cocos nucifera*), Castor (*Ricinus communis*), Soyabean (*Glycine max*) and performing tests for oil.
4. Study of morphology and alkaloid present in spices: Ginger (*Zingiber officinale*), Turmeric (*Curcuma longa*), Coriander (*Coriandrum sativum*), Clove (*Eugenia aromaticum*), Black Pepper (*Piper nigrum*), Cinnamon (*Cinnamomum zeylanicum*)
5. Study of morphology and medicinal value for medicinal plants: Amla (*Emblica officinalis*), Bahera (*Terminalia belerica*), Harhar (*Terminalia chibula*), Sarpagandha

- (*Rauwolfia serpentine*), Ashwgandha (*Withania somnifera*), Liquorice (*Glycyrrhiza glabra*), Poppy (*Papaversomniferum*), Arjuna (*Terminalia arjuna*)
6. Study of morphology and nutrition value for pulses: Green Gram (*Phaseolus aureus*), Black Gram (*Phaseolus mungo*), Pigeon Pea (*Cajanas cajan*), Kidney Bean (*Phaseolus vulgaris*)
 7. 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*)
 8. Vegetables: Potato (*Solanum tuberosum*), Radish (*Rapahnus sativus*), Turnip (*Brassica rapa*)
 9. Study of morphology of Beverages: Tea (*Thea sinensis*), Coffee (*Coffea arabica*) and knowledge of processing method.

Suggested Practical's based on MBTL-3076

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

Master of Science (Botany) Semester-IV (Session 2026-2027)
Course Title: Plant Anatomy
Course Code: MBTL –4071

Course outcomes:

After passing this course the student will be able to:

CO1: Compare anatomy of primary and secondary growth in roots as well as shoots.

CO2: Understand anatomy of different types of woods and their commercial utilization.

CO3: Understand floral, fruit and seed anatomy.

CO4: Relate anatomy of the plant part with their physiological role.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Plant Anatomy
Course Code: MBTL –4071

LTP:3-0-0

Max. Marks-100

Theory - 70

CA – 30

Examination Time: 3 hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

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, anomalous secondary growth, polycyclic vasculature, secondary meristems, origin and function, the role of pericycle, phellogen, phellem, phelloderm, distribution of sclerenchyma in leaves, stem 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 common hard and soft woods of 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 mycorrhizas.

Reference Books:

1. Carlquist S (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.

2. Crang R., Lyons-Sobaski S., & Wise R. (2018). Plant anatomy: a concept-based approach to the structure of seed plants. Springer.
3. Cutler DF, Botha CEJ, Stevenson DW (2007). Plant Anatomy - An Applied Approach, Blackwell Publishing, USA
4. Cutter EG (1978) Plant Anatomy, Part I & II, Edward Arnold, United Kingdom.
5. Dickinson WC (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
6. Nair MNB (1998). Wood Anatomy and Major Uses of Wood, Faculty of Forestry, University of Putra Malaysia, Malaysia.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Structure and Metabolism of Plant Hormones
Course Code: MBTL – 4072

Course outcomes:

After passing this course the student will be able to:

CO1: Understand the history and role of different types of plant hormones in growth and development of plants.

CO2: Understand the mechanism of common plant hormones, bioassays and their commercial use.

CO3: Understand biosynthesis, action and uses of new class of plant hormones.

CO4: Relate microbial association with the production of growth regulators.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Structure and Metabolism of Plant Hormones
Course Code: MBTL – 4072

LTP: 3-0-0

Max. Marks- 100

Theory- 70

CA – 30

Examination Time: 3 hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

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

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 occurring auxins, synthetic auxins, structural diversity of auxins.

UNIT-II

Gibberellins (GAs): Discovery, structure and physiological roles of GAs in higher plants, terpenoid pathway, biosynthesis ; regulation of endogenous levels, and other substances with GA-like activity.

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, biosynthesis in higher plants, regulation of cytokinin levels, synthetic compounds with cytokinin like activity, cytokinin antagonists (anticytokinins).

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.

Abscissic Acid: Discovery, structure and occurrence in plants and fungi, physiological roles of abscissic acid (ABA), biosynthesis of ABA, carotenoid and/or ABA synthesis, mutants, ABA synthesis inhibitors, regulation of ABA levels.

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

UNIT-IV

Jasmonates and other Defense-Related Compounds: Introduction, discovery, distribution, and structure of jasmonates, physiological roles of jasmonates, biosynthesis of jasmonic acid (JA), JA synthesis mutants, JA synthesis inhibitors, regulation of endogenous levels of JA.

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.

Reference Books:

1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). (2015). *Biochemistry and molecular biology of plants*. John Wiley & Sons. American Society of Plant Physiologists, Maryland.
2. Davies, P. J. (Ed.). (2004). *Plant hormones: biosynthesis, signal transduction, action!* Springer Science & Business Media.
3. Dennis, D.T., Turpin, D.H., Lefebvre, D.D., and Layzell, D.B. (eds) (1997). *Plant Metabolism*. Longman, Essex.
4. Galston, A.W. (1989). *Life Processes in Plants*. Scientific American Library, Springer-Verlag, New York.
5. Hooykaas, P.J.J., Hall, M.A., and Libbenga, K.R. (eds) (1999). *Biochemistry and Molecular Biology of Plant Hormones*. Elsevier, Amsterdam.
6. Hopkins, W. G. (2007). *Introduction to plant physiology* 4th edition. John Wiley & Sons, Inc., New York.
7. Lodish, H., Berk, A., Zipursky, S.I., Matsudaira, P., Baltimore, D., and Darnell, J. (2000). *Molecular Cell Biology*. W.H. Freeman and Company, New York.
8. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant physiology and development*, Sinauer Associates Inc

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Plant Tissue Culture and Biotechnology
Course Code: MBTL – 4073

Course outcomes:

After passing this course the student will be able to:

CO1: Understand the concept of cytogenetics, differentiation in cell and tissue culture and mechanism, advantage and disadvantages of micro-propagation.

CO2: Understand the mechanism of production of disease resistant, herbicide resistant and pathogen free plants.

CO3: Describe the role of tissue culture in the production of different types of transgenic plants.

CO4: Explain the role of plant tissue culture and biotechnology in different fields of human interest.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Plant Tissue Culture and Biotechnology
Course Code: MBTL – 4073

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Plant Tissue Culture: Introduction and Historical aspects of Tissue Culture, Micropropagation: Stages, Types, Cytogenetics and differentiation in cell and tissue culture, plant regeneration from callus, shoot apex culture and anthers. Somatic embryogenesis, usefulness, hardening of micro propagated plantlets, advantages and disadvantages, application of the technique in crop improvement.

UNIT-II

Somaclonal variations: Soma clonal variations and isolation of useful mutants at cellular level, disease resistance, herbicide resistance and salt tolerance. Production of pathogen free plants through tissue culture. Production of artificial seeds, their use and application.

UNIT-III

Techniques for the production of transgenic plants: Concept, vector less transgenesis, gene targeting tools, crop improvement through transgenics, benefits and risk of producing transgenic plants, commercialization of transgenics. Cell culture and secondary metabolites like cinnamic acid, shikonin, flavonoids and related compounds production.

UNIT-IV

Cryobiology of plant cell cultures and establishment of plant banks, freeze preservation technology, factors influencing revival of frozen cells and future prospects. Terminator technology, verminator technology, apprehensions and challenges.

Role of plant tissue culture and biotechnology in agriculture, medicine and human welfare, prospects of genetic engineering of plants.

Reference Books:

1. Bhojwani, SS and Dantu, PK (2013) Plant Tissue Culture: An introductory text, Springer Publications.
2. George, F.E., Hall, M., Klerk G. J (2008) Plant propagation by Tissue culture 3rd edition VolI, Springer Publications.
3. Gupta P.K., (1990), An Introduction to Biotechnology, Rastogi Publications, Meerut.

4. Kung, Shain – Dow and Arntzen, C.J. (1989). Plant Biotechnology, Butter Worths, London.
5. Old, R.W. and Primrose S.B. (1991). Principles of Gene Manipulation, And Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.
6. Reinert, J. and Bajaj, Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Springer Verlag, Berlin.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Analytical Techniques
Course Code: MBTL – 4074

Course outcomes:

After passing this course the student will be able to:

CO1: Understand working of different microscopes.

CO2: Understand the basics of the major analytic techniques including sample preparation, standardization and data analysis of each technique.

CO3: Understand working of different spectroscopy techniques.

CO4: Understand theory and practice of different blotting techniques.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Analytical Techniques
Course Code: MBTL – 4074

LTP: 3-0-0

Max. Marks- 100

Theory -70

CA – 30

Examination Time: 3 hrs

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

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

UNIT-II

Principles and applications of gel filtration, ion-exchange and affinity chromatography, thin layer and gas chromatography, high pressure liquid chromatography (HPLC), electrophoresis and electrofocussing, ultra-centrifugation (velocity and density gradient).

UNIT-III

Principles of biophysical methods used for analysis of biopolymeric structure, X-ray diffraction fluorescence UV/CD, visible Nuclear Magnetic Resonance (NMR) and Electron Spin Resonance (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 Western blotting techniques; Polymerase chain reaction.

Reference Books:

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
4. Spring Harbor Lab. Press.Sheehan, D. (2000). Physical Biochemistry: Principles and Applications, John Wiley andSons 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. (198)

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Diversity and Biology of Angiosperms
Course Code: MBTL – 4075

Course outcomes:

After passing this course the student will be able to:

- CO1: Learn about different systems of classification with their merits and demerits.
- CO2: Understand principles of plant nomenclature, origin of angiosperms and phylogeny.
- CO3: Understand the role of various fields of biology in plant taxonomy.
- CO4: Understand the concepts of taxonomic tools, aspects related to phytogeography and local plant diversity.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Taxonomy of Angiosperms
Course Code: MBTL – 4075

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

Historical perspective of plant classification, phenetic versus phylogenetic system; cladistics in taxonomy, relative merits and demerits of major system of classification, a study of phylogenetic system of classification after Engler&Prantl, Bessey, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne.

UNIT-II

Principles of plant nomenclature; salient features of the International code of Botanical Nomenclature, working knowledge of botanical latin, important herbaria of the World. Origin of angiosperms; interrelationships of dicots and monocots; Phylogeny of Ranales, Amentiferae, Centrospermae, Tubiflorae and Helobiales and their treatment in the modern systems of classification.

UNIT-III

Principles of plant taxonomy, alpha taxonomy vs modern taxonomy; chemotaxonomy, cytotaxonomy, numerical taxonomy, anatomy, palynology and embryology in relation to taxonomy. Biosystematic approach to taxonomy, biosystematic categories parameters in biosystematic analysis with particular examples of taxonomic problems; taxonomic study of agamic, hybrid and polyploid complexes; phylogenetic trees.

UNIT-IV

Taxonomic tools: Herbarium; floras; serology; electrophoresis; nucleic acid hybridization; computers and GIS. Concepts of phytogeography and its relevance, phytogeographic regions of the world and India, approaches to phytogeography, principles and practices; factors determining vegetational types, endemism, hotspots and hottest hotspots, plant explorations, invasions and introductions, local plant diversity and its socioeconomic importance.

Reference Books:

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 AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition)
4. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
5. Brown, H.P. (1989). An Elementary Manual of Indian Tree Technology, Dehradun
6. Davis P.H. and Heywood, V.H. (1973). Principles of Angiosperms Taxonomy. Robert E. Kreiger. Co., New York.
7. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002) Plant Systematics: A Phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
8. Nei M and Kumar S (2000) Molecular Evolution and Phylogenetics. Oxford University Press, New York.
9. Raven PH, Begg LR, Hassenzahl DM (2008) Environment. 6th edition. John Wiley & Sons, Inc., New York.
10. Semple C and Steel MA (2003) Phylogenetics. Oxford University Press, Oxford

Master of Science (Botany) Semester- IV (Session 2026-2027)

**Course Title: Hazardous Chemicals
(Optional Paper)**

Course Code: MBTL-4076(opt-I)

Course outcomes:

After passing this course the student will be able to:

CO1: Understand different types of hazardous chemicals and how we can expose to them.

CO2: Understand control measures that reduce the risk associated with hazardous chemicals.

CO3: Manage hazardous chemicals effectively.

CO4: Describe the processes involved in hazardous waste treatment.

Master of Science (Botany) Semester- IV (Session 2026-2027)

Course Title: Hazardous Chemicals

(Optional Paper)

Course Code: MBTL-4076 (Opt-I)

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

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

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 properties.

UNIT-II

Aldehydes: Acrolein.

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

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: HCN, Sodium cyanide, potassium cyanide, cyanogen.

Organic Isocyanates: Methyl isocyanate.

UNIT-III

Dioxins: 2,3,7,8 – Tetrachlordibenzo-p-dioxin (TCDD).

Epoxy Compounds: Ethylene dioxide.

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, LD50/ LC50, health hazards and exposure limit of following pesticides:

Carbamates: Aldicarb, Carbaryl, Carbofuran, Methiocarb.

Organochlorines: Aldrin, Dieldrin, Endrin, Heptachlor, Chloradane, Endsulphan, DDT, Methoxychlor, Lindane.

Organophosphorus Pesticides: Parathion, Dichlorophos, Monocrotophos, Chloropyriphos.

Herbicides: 2,4 D, 2,4, T, Silvex, Atrazine, Metribuzin, Monouron, Diuron, Paraquat, Tribunil, Alchlor

Reference Books:

1. Patnaik, P. (1999). A Comprehensive Guide to the Hazardous Properties of Chemical Substances. Wiley, New York.

Master of Science (Botany) Semester- IV (Session 2026-2027)

Course Title: Immunology

(Optional Paper)

Course Code: MBTL-4076(Opt-II)

Course outcomes:

After passing this course the student will be able to:

CO1: Understand history and principles of immunology.

CO2: Conceptualize how the antigen is processed.

CO3: Understand the working of Antibodies.

CO4: Understand the cells and tissues of the immune system.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Immunology (Optional Paper)
Course Code: MBTL-4076(Opt-II)

LTP: 3-0-0

Max. Marks- 100

Theory - 70

CA – 30

Examination Time: 3 hrs.

Instructions for the Paper Setters:

Eight questions of equal marks (i.e. 14 marks each) are to be set, two in each of the four sections (A-D). Questions of section (A-D) should be set from Unit (I-IV) of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

UNIT-I

An Overview of the Immune System: Historical perspective, an introduction to the immune system – innate and adaptive immunity. Immuno deficiencies: secondary immunodeficiency disorders.

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. The immune system in Health & Disease, specially AIDS.

Reference Books:

1. Abbas, A.K., Lichtman, A.H. and Pillai, S. (2021). *Cellular and Molecular Immunology* (10th Edition). Elsevier.
2. Abbas, A.K., Lichtman, A.H. and Pillai, S. (2023). *Basic Immunology: Functions and Disorders of the Immune System* (7th Edition). Elsevier.
3. Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. (2017). *Roitt's Essential Immunology* (13th Edition). John Wiley & Sons.
4. Goldsby, R.A., Kindt, T.J., Osborne, B.A. and Kuby, J. (2003). *Immunology* (5th Edition). W.H. Freeman and Company, New York.
5. Murphy, K. and Weaver, C. (2022). *Janeway's Immunobiology* (10th Edition). Garland Science / W.W. Norton.
6. Punt, J., Stranford, S.A., Jones, P.P. and Owen, J.A. (2023). *Kuby Immunology* (8th Edition, COVID-19 and Digital Update). Macmillan Learning.
7. Stanley, J. (2002). *Essentials of Immunology and Serology*. Delmar Thomson Learning, USA.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Botany Practical I
Course Code: MBTP -4077

(Based on MBTL-4071, MBTL-4072 and MBTL-4073)

Course outcomes:

After passing this course the student will be able to:

CO1: Develop skills of dissection, formation of temporary and permanent slides.

CO2: Understand commercial applications of plant growth hormones.

CO3: Perform bioassays of plant growth regulators.

CO4: Study the functions and operations of various instruments used in PTC

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Botany practical VII
Course Code: MBTP -4077

(Based on MBTL-4071, MBTL-4072 and MBTL-4073)

LTP: 0-0-3

Max. Marks- 100

Practical - 70

CA – 30

Examination Time: 6 hrs.

Instructions for the Paper Setters: 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, Kanya Mahavidyalaya, Jalandhar.

Suggested Practical based on MBTL-4071

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. Anatomical studies of young and mature stem of *Helianthus*.
6. Comparative anatomy of dicot and monocot root, stem and leaf
7. To study anomalous stem behaviour in stem (*Mirabilis jalapa*, *Nyctanthus*, *Boerhaaviadiffusa*, *Bignonia*, *Dracaena*.)
8. Study of anatomical features in xerophytes e.g. (leaf of *Nerium*. stem and leaf of *Calotropis*, phyllocladode of *Ruscus*.)
9. Study of anatomical features in hydrophytes e.g. (*Nelumbopetiole*, *Hydrillastem* and leaf, *Eichhorniapetiole*, leaf lamina, *Typha*)
10. To study anatomy of storage roots of e.g. (*Raphnussativa*, *Beta vulgaris*.)
11. To study anatomy of halophytes e.g. (*Chenopodium* stem)
12. To study permanent tissues slides.

Suggested Practical's based on MBTL-4072

1. Study the effect of IAA on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
2. To study the effect of IBA on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
3. Study the effect of Gibberellins on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
4. Study the effect of Cytokinin on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
5. Estimation of the catalase activity by Aebi's Method.
6. Study of bioassays of Auxins, Gibberellins, Cytokinin, Ethylene, Absciscic Acid and Brassinosteroids.
7. Study of antagonistic effect of cytokinin/ethrel on senescence behavior of leaves of different field crops.

Suggested Practical's based on MBTL-4073

1. To study the functions and operations of various instruments used in PTC like Laminar Air Flow, Autoclave, incubators, oven, Distillation unit, Weighing balance, pH meter
2. Laboratory design set up of PTC lab Sterilisation techniques
3. Different types of Enclosures used in PTC
4. Preparation of stock solutions and media preparation
5. Selection, preparation and inoculation of explant Synthetic Seed Production
6. Micropropagation and its different steps. Significance of growth hormones in culture
7. Induction of callus from different explants Anther culture and ovary culture

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Botany Practical VIII
Course Code: MBTP -4078

(Based on MBTL-4074 and MBTL-4075)

Course outcomes:

After passing this course the student will be able to:

CO1: Understand and perform experiments based on different analytic techniques.

CO2: Identify different plants using identification keys.

CO3: Explore rich plant biodiversity.

CO4: Compare different species of a genus and different genera of family.

Master of Science (Botany) Semester- IV (Session 2026-2027)

Course Title: Botany Practical VIII

Course Code: MBTP -4078

(Based on MBTL-4074 and MBTL-4075)

LTP: 0-0-2

Max. Marks- 50

Practical - 35

CA – 15

Examination Time: 4 hrs.

Instructions for the Paper Setters: 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, Kanya Mahavidyalaya, Jalandhar.

Suggested practicals based on MBTL-4074

(Experiments based on following techniques):

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

Suggested Practicals based on MBTL-4075

Description of specimen from representatives of locally available Plants. This list is indicative only

- Ranunculaceae: *Ranunculus*, *Delphinium*,
- Brassicaceae: *Brassica*, *Iberis*
- Malvaceae: *Hibiscus*
- Rutaceae: *Murraya*, *Citrus*
- Fabaceae: *Lathyrus*, *Cassia*, *Acacia*, *Mimosa*
- Rosaceae: *Rose*, *Prunus*
- Asteraceae: *Helianthus*, *Ageratum*, *Sonchus*
- Apiaceae: *Coriandrum*, *Foeniculum*
- Apocynaceae: *Vinca*, *Nerium*, *Thevetia*
- Asclepiadaceae: *Calotropis*
- Solanaceae: *Petunia*, *Solanum*, *Datura*
- Euphorbiaceae: *Euphorbia*, *Phyllanthus*
- Lamiaceae: *Ocimum*, *Salvia*
- Chenopodiaceae: *Chenopodium*
- Liliaceae: *Asparagus*, *Asphodelus*
- Poaceae: *Triticum*, *Avena*

1. Location of key character and use of keys at family level.
2. Field trips within and around the campus; compilation of field note and preparation of herbarium sheets of such plant, wild or cultivated as are abundant.
3. Training in using flora and herbaria for identification of specimen described in the class
4. Comparison of different species of a genus and different genera of family to calculate similarity coefficients.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Research Techniques/Research Project
Course Code: MBTD-4079

Course outcomes:

After passing this course the student will be able to:

CO1: Understand plant collection, their preservation and importance in taxonomic studies

CO2: Understand a general definition of research design

CO3: Identify the overall process of designing a research study from its inception to its report.

CO4: Understand ethical issues in educational research.

Master of Science (Botany) Semester- IV (Session 2026-2027)
Course Title: Research Techniques/Research Project
Course Code: MBTD-4079

LTP: 0-0-1

Max. Marks- 50

Evaluation Report - 35

CA – 15

Field Study:

1. Collection and preservation of plants
(a) from local excursion (short) (b) Major excursion (long)
2. Identification of Plants
3. Preparation of Herbarium.
4. Submission of report for every field study
5. Submission of compiled herbarium at the time of End Sem. Exam.

Research Techniques:

1. Introduction: Research design, principles, execution of work, interpretation of results.
2. Review of literature: Structure of a scientific library, journals, books, Digital library, and E books
3. Layout of a Research Paper, Journals in Botanical Science, Impact factor of Journals
4. Google Scholar, Open source, bibliography management system.
5. Methods of data collection
6. Data analysis: Measures of Central tendencies (Mean, mode, median,) Standard deviation, the variance and coefficient of variation, Correlation and regression, ANOVA using SPSS
7. Ethics in research related to publishing, Plagiarism and Self-Plagiarism.

Reference Books:

1. Thomas, C. G. (2021). *Research Methodology and Scientific Writing*. Thrissur: Springer.
2. Bairagi, V., & Munot, M. V. (Eds.). (2019). *Research Methodology: A Practical and Scientific Approach*. CRC Press.
3. Jain, S. (2019). *Research Methodology in Arts, science and Humanities*. Society Publishing.
4. Kothari, C. R. (2016). *Research Methodology: Methods and Techniques*. New Age International Publishers.