## VIDYASAGAR UNIVERSITY

Midnapore, West Bengal



PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF

# BACHELOR OF SCIENCE (HONOURS) MAJOR IN BOTANY

## 4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes (CCFUP), 2023 & NEP, 2020

## VIDYASAGAR UNIVERSITY BACHELOR OF SCIENCE (HONOURS) MAJOR IN BOTANY (under CCFUP, 2023)

Level	YR.	SEM	Course	Course Code	Course Title	Credit	L-T-P	Marks		
			Type					CA	ESE	TOTAL
		V 3rd			SEMESTER-V		I.		ı	
			Major-8	BOTHMJ08	T: Genetics and Plant Breeding; P: Practical	4	3-0-1	15	60	75
			Major-9	BOTHMJ09	T: Molecular Biology and Plant Biotechnology;	4	3-0-1	15	60	75
					P: Practical					
			Major-10	BOTHMJ10	P: Palynology and Plant Reproductive Biology;	4	3-1-0	15	60	75
B.Sc. (Hons.)	3rd				P: Practical					
			Major	BOTHDSE1	Stress Biology OR	4	3-1-0/	15	60	75
			Elective-01		Industrial and Environmental Microbiology		3-0-1			
			Minor-5	BOTMIN05	T: Plant Science-V; P: Practical	4	3-0-1	15	60	75
			(DiscI)		(To be taken from other Discipline)					
					Semester-V Total	20				375

MJ = Major, MI = Minor Course, DSE = Discipline Specific Elective Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

## **SEMESTER-V**

## MAJOR (MJ)

**MJ-8: Genetics and Plant Breeding** 

Credits 04 (Full Marks: 75)

**MJ-8T:** Genetics and Plant Breeding (Theory)

Credits 03

Unit	Торіс
Unit- 1	Mendelian genetics and its extension: Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Polygenic inheritance.
Unit-2	Extensions of Mendelian principles: dominant epistasis (12:3:1), supplementary gene action (9:3:4), polygenic action (9:6:1), complementary gene action (9:7), inhibitory gene action (13:3), duplicate gene action (15:1)
Unit-3	Extra-chromosomal Inheritance: Organelle effects- Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium.
Unit-4	Linkage, crossing over and chromosome mapping: Linkage and crossing over- Cytological and molecular basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping.
Unit-5	Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogues, deamination, and intercalating agents); DNA repair mechanisms. Transposable elements and its role; Retroposon.
Unit-6	Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law and Factors-, role of natural selection, mutation, bottle neck, genetic drift, and founder effect.
Unit-7	Plant Breeding: Introduction and objectives. Breeding methods: self-pollinated, cross pollinated and vegetative propagated plants; Distant hybridization and role of biotechnology in crop improvement. Heterosis and Inbreeding Depression

#### **Course Outline:**

- 1. Basic schedules for chromosome preparation: Pre-treatment, Fixation, Staining, and Smear preparations.
- 2. Study of Mitosis through smear preparation of root tip of Allium cepa,/ Allium sativum/ Aloe vera
- 3. Study of Meiosis through smear preparation of root tip of *Allium cepa*,/ *Rhoeo sp.*
- 4. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
- 5. Incomplete dominance and gene interaction through plant samples (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
- 6. Demonstration of hybridization technique in a papilionaceous flower (*Cajanas cajan*) and in a graminaceous flower (*Oryza sativa*).
- 7. Demonstration of T-budding, I-budding in rose. Demonstration of grafting (Wedge grafting, V-grafting, tongue grafting, side grafting) and air layering (gootie) of plant specimens.

#### **Recommended Readings**

- 1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John
- 2. Wiley & sons, India. 8th edition.
- 3. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India.5th edition.
- 4. Kluz, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics.
- 5. Benjamin Cummings, U.S.A. 9th edition.
- 6. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to
- 7. Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
- 8. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7<sup>th</sup> edition.
- 9. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford-IBH. 2<sup>n</sup> edition.
- 10. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

## MJ-9: Molecular Biology and Plant Biotechnology

Credits 04 (Full Marks: 75)

MJ-9T: Molecular Biology and Plant Biotechnology (Theory) Credits 03

Unit	Торіс
Unit- 1	Nucleic acids: Carriers of genetic information  Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment. DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA in Prokaryotes, Viruses, and Eukaryotes. RNA Structure; Organelles DNA- mitochondria and chloroplast. Nucleosome structure; Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.
Unit 2	The replication of DNA Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, $\theta$ (theta) mode of replication; Enzymes involved in DNA replication.
Unit 3	Central dogma and genetic code The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (salient features and deciphering)
Unit 4	<b>Transcription</b> Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in <i>E.coli</i> . Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.
Unit 5	Processing and modification of RNA Split genes-concept of introns and exons, Splicing- mechanism and types, eukaryotic mRNA processing (5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport.
Unit 6	Translation Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Protein synthesis- mechanism in Prokaryotes and Eukaryotes; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Unit 7	Plant Tissue Culture Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Somatic Embryogenesis; Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploid culture; Cryopreservation; Germplasm Conservation).
Unit 8	Recombinant DNA technology Restriction Endonucleases (Types, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pBR322, pUC18/19, Ti plasmid); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC) and expression vector
Unit 9	Gene Cloning Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; DNA library, construction of genomic and cDNA libraries; complementation, and colony hybridization.
Unit 10	Methods of gene transfer  Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection,  Microprojectile bombardment; Selection of transgenics—selectable marker and reporter genes  (Luciferase, GUS, GFP).
Unit 11	Applications of Biotechnology Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products—Humulin; Biosafety concerns.

## MJ-9P: Molecular Biology and (Practical)

#### Credits 01

#### **Molecular Biology:**

- 1. Preparation of LB and MS medium and raising E. coli.
- 2. Isolation of plasmid DNA from E. coli; Restriction digestion and gel electrophoresis of plasmid DNA.
- 3. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
- 4. RNA estimation by Orcinol method.
- 5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
- 6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.

## **Plant Biotechnology:**

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

## **Suggested Reading:**

- a. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
- b. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
- c. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings,
- 2. U.S.A. 3<sup>rd</sup> edition.
- a. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
- 3. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- 4. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- 5. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
- 6. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
- 7. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- 8. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- 9. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
- 10. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
- 11. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

## MJ-10: Palynology and Plant Reproductive Biology Credits 04(Full Marks: 75)

## MJ-10T: Palynology and Plant Reproductive Biology (Theory) Credits 03

Unit	Торіс
Unit 1	Introduction History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.
Unit 2	Reproductive development Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.
Unit 3	Anther and pollen biology Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (Male Germ Unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.
Unit 4	Ovule Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female Gametophyte – megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of <i>Polygonum</i> type); Organization and ultrastructure of mature embryo sac.
Unit 5	Pollination and fertilization Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.
Unit 6	Self-incompatibility Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and <i>in vitro</i> pollination; Modification of stigma surface, parasexual hybridization; Cybrids, <i>in vitro</i> fertilization.
Unit 7	Embryo, Endosperm and Seed Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in <i>Paeonia</i> . Seed structure, importance and dispersal mechanisms.
Units 8	Polyembryony and apomixis Introduction; Classification; Causes and applications.

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

## **Suggested readings:**

- 1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
- 2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
- 3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
- 4. Johri, B.M. 1 (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

#### **MAJOR ELECTIVE (DSE)**

Major Elective -1: Stress Biology Credits 04(Full Marks: 75)

**MJ DSE-1T: Stress Biology (Theory)** 

Credits 03

Unit	Course contents
Unit 1	Defining plant stress: Acclimation and adaptation
Unit 2	Environmental factors: Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis—related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates
Unit 3	Stress sensing mechanisms in plants: Calcium modulation, Phospholipid signaling
Unit 4	Developmental and physiological mechanisms that protect plants against environmental stress: Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production.
Unit 5	Reactive oxygen species—Production and scavenging mechanisms.

## **MJ DSE-1P: Stress Biology (Practical)**

Credits 01

- 1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
- 2. Superoxide activity in seedlings in the absence and presence of salt stress.
- 3. Zymographic analysis of peroxidase.
- 4. Zymographic analysis of superoxide dismutase activity.
- 5. Quantitative estimation and zymographic analysis of catalase.
- 6. Quantitative estimation and zymographic analysis of glutathione reductase.
- 7. Estimation of superoxide anions.

## **Suggested Readings:**

- 1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John
- 2. Wiley and Sons. U.S.A. 4th edition.
- 3. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and

OR

## Major Elective -1: Industrial and Environmental Microbiology Credits 04(FM: 75)

## MJ DSE-1T: Industrial and Environmental Microbiology (Theory) Credits 03

Unit	Course contents
Unit 1	Scope of microbes in industry and environment
Unit 2	Bioreactors / Fermenters and fermentation processes
	Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.
Unit 3	Microbial production of industrial products
	Microorganisms involved, media, fermentation conditions, downstream processing and
	uses; spray drying; Hands on microbial fermentations for the production and estimation
	(qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric
	acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin)
Unit 4	Microbial enzymes of industrial interest and enzyme immobilization:
	Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).
Unit 5	Microbes and quality of environment.
	Distribution of microbes in air; Isolation of microorganisms from soil, air and water
Unit 6	Microbial flora of water.  Water pollution, role of microbes in sewage and domestic waste water treatment systems.  Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.
Unit 7	Microbes in agriculture and remediation of contaminated soils
	Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root
	nodulating bacteria, arbuscular mycorrhizal colonization in plant roots

## MJ DSE-1T: Industrial and Environmental Microbiology (Practical)

Credits 01

- a. Principles and functioning of instruments in microbiology laboratory.
- b. Hands on sterilization techniques and preparation of culture media.
- c. Isolation of microorganisms from soil.
- d. Demonstration of filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization,
- e. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

## **Suggested Readings:**

- 1. Pelzer, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
- 2. Torbra, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

## MINOR (MI)

Minor (MI)-5: Plant Science-V

Credits 04(Full Marks: 75)

<b>Minor (MI)-5T: Plant Science-</b>	(Biochemistry and Metabolism)	Credits 03
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Unit	Topic
1.	Bioenergetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic
	reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency
	molecule.
2.	Forces stabilizing atomic and molecular interactions: Formation, properties and
	biological significance of Van der Waals force, hydrogen bond, ionic bond, covalent bond
	and hydrophobic interaction, free radicals. pH and buffer: biological significance of pH,
	Characteristics of buffer.
3.	Carbohydrate chemistry: Classification and properties of carbohydrates with emphasis on
	glycosidic bond,
4.	<b>Protein chemistry:</b> Classification of proteins, primary, secondary, tertiary and quaternary
	structure of proteins; Properties of proteins.
5.	Lipid Chemistry: Definition and major classes of storage and structural lipids; Fatty acids
	structure and functions; Essential fatty acids; Triacylglycerols structure, functions and
	properties; Phosphoglycerides.
6.	Nucleic acid chemistry: Elementary concept of nucleoside, nucleotide, polynucleotide,
	elementary concept of DNA and RNA.
7.	Enzymes:Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and
	prosthetic group; Classification of enzymes; isoenzymes; Features of active site, substrate
	specificity, mechanism of action (activation energy), Michaelis – Menten equation.

## **Minor (MI)-5P: Plant Science-V (Practical)**

Credits 01

- 1. **Qualitative tests for-carbohydrates** of reducing and non-reducing sugars, glucose, fructose, sucrose, starch and **-lipids**.
- 2. Qualitative tests for detection of proteins, amino acids and organic acids (citric, oxalic. Qualitative tests for carbohydrate, protein, lipid.

## **Suggested Readings:**

- 1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
- 2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
- 3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
- 4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company