SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBOT01	Fungal Biology and Plant–Pathogen Interactions	4-0-1	**120**	04

Course Learning Outcomes (CLOs):

On completion of this course, students will be able to:

CLO1: Explain the classification, diversity, and general characteristics of fungi based on classical and modern taxonomic systems, and interpret their ecological and economic significance.

CLO2: Describe in detail the morphology, cellular organization, reproduction, and life cycles of fungi, lichens, and related groups, and compare their structural and functional adaptations.

CLO3: Apply principles and techniques of mushroom cultivation, including composting, spawning, and harvesting, and evaluate their economic and commercial importance.

CLO4: Analyze the development of plant diseases using the disease triangle concept by correlating host, pathogen, and environmental factors, and interpret disease progression.

CLO5: Evaluate symptoms, etiology, life cycles, and management strategies of major plant diseases caused by fungi, bacteria, and viruses, and propose appropriate control measures.

CLO6: Interpret host–pathogen interactions and plant defense mechanisms, including hypersensitive response (HR), systemic acquired resistance (SAR), and molecular signaling pathways involved in plant immunity.

Unit	Course Content	Learning Pedagogies*	CO(s)

I	• **Fungal Biology and Diversity**
	• Introduction to Fungi: History and classification of Fungi (Alexopoulos, 1962, Ainsworth 1973, Kirk et.al. 2008).
	• Fungi: General characteristics, Economic importance of fungi.
	• Life cycle, morphology, structure and reproduction in
	  • Kingdom: Fungi
	  • Kingdom: Chromista
	  • Kingdom: Protozoa.
		Classroom Lecture, Seminars, Case-Based Learning, ICT-Enabled Learning, Self-Directed Learning	1, 2

II	• **Commercial Applications of Fungi** • Lichens: Morphology, reproduction and economic importance. • Techniques of mushroom cultivation: Schedule and systems of cultivation; composting; peak heating; spawn preparation and mushroom stains spawning and mycelia growth; supplementation; • cultivation technique from casing to ruffling and recovery growth to harvesting; pests and diseases and its protection.	Classroom Lecture, Seminars, Case-Based Learning, ICT-Enabled Learning Self-Directed Learning, Experiential Learning	2, 3

III	• **Plant pathogen and plant diseases** • The disease triangle: Role of environment, host and pathogen in disease formation. • Symptoms, life cycle and control of fungal diseases: Rusts, smuts, blast, red-rot, powdery mildew and tikka diseases. • Symptoms, life cycle and control of bacterial and viral diseases: Leaf blight, canker, leaf spot, Mosaic, panama and leaf curl diseases.	Classroom Lecture, Seminars, Case-Based Learning, ICT-Enabled Learning, Self-Directed Learning	4, 5
IV	• **Disease control and plant pathogen interaction** • Control measures for plant diseases. • Chemical control, biological control and integrated disease and pest management. • Host- pathogen interactions, plant defence mechanisms. • HR and SAR in plant defence. • Molecular mechanisms and signaling pathways in plant defenses.	Classroom Lecture, Seminars, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning Self-Directed Learning	5, 6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30 marks)

(a) **Quiz (2 quizzes):** 10 marks
(b) **Seminar:** 05 marks
(c) **Assignment**: 05 marks
(d) **Regularity:** 05 marks
(e) **Group Learning:** 05 marks

b. Internal Summative Assessment: Mid-term tests (20 marks)

(B) External Assessment: End of Term Examination (50 marks)

(B) Weightage of Learning Efforts for Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1, 2	30	3	3	6	12
I	2, 3	30	2	5	3	12
III	4, 5	30	3	5	6	12
IV	5, 6	30	2	5	7	14
		120	10	18	22	50

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- **CLOs – PLOs Matrix**

CLO/ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO12	PLO13
CLO1	3	2	1	1	1	1	1	1	1	1	1	1
CLO2	3	2	2	1	1	1	1	1	1	1	1	1
CLO3	2	2	3	2	3	1	1	2	2	1	1	2
CLO4	2	3	3	2	2	2	1	2	3	1	1	2
CLO5	2	2	3	2	3	3	2	3	3	2	1	2
CLO6	2	3	2	2	2	3	2	3	3	2	1	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	**3**
Moderate	**2**
Low	**1**
No correlation	**-**

- **Assessment and Evaluation**

Sr.No	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/ Year	Publisher
1	Introductory Mycology	Alexopoulos et al.	--	Wiley
2	An Introduction to Fungi	H.C. Dube	--	Scientific Publishers
3	Principles of Plant Pathology	R.S. Singh	--	Oxford & IBH
4	Plant Diseases	R.S. Singh	--	Oxford & IBH
5	Plant Pathology	Agrios	--	Elsevier

- **Online Resources (Open Source)**

Sr.No.	Description of Resource(s)	Weblink
1	General Microbiology	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec19_bt11
2	Mushroom Production	https://onlinecourses.swayam2.ac.in/e-learning/preview/nos20_ge07
3	Plant Pathology and Soil Health	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec25_bt06
4	Diseases of horticultural crop	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec20_ag11

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Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBOT02	Biosystematics of Angiosperm	4-0-1	120	04

Course Learning Outcomes (CLOs):

On completion of this course, students will be able to:

CLO1: Identify and classify local flowering plants using taxonomic keys

CLO2: Appraise different systems of plant classifications

CLO3: Apply different principles and rules for naming plants and changing names

CLO4: Create identification keys for local flora

CLO5: Apply modern tools and techniques in plant systematics

CLO6: Perform field collections and process the plant samples, prepare and preserve herbarium specimens

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	• Biosystematics: Concepts, components and methods; relevance of biosystematics. • Taxonomic hierarchy; Concept of taxa (family, genus, species) • Taxonomic evidence: morphological; palynological; chromosomal and phytochemical data in plant systematics.	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL)	01,02
II	• Classification systems: A brief history of plant classifications from Linnaeus to APG IV. An overview of the principles, merits and demerits of major classifications systems of flowering plants. • Salient features and inter-relationships of major clades of APGIV. • Molecular systematics: Concepts and methods, molecular markers, DNA sequence data, DNA barcoding.	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL)	03
III	• Plant identification: Different methods of plant identification, taxonomic keys, floras and monographs.	Classroom Lecture (CL), Seminars (Student-led and	04

	● Botanical nomenclature: naming plants; scientific *vs* vernacular names, binomial nomenclature. ● International Code of Nomenclature for Algae, Fungi and Plants (ICN): Principles, rules and recommendations covering typification, nomenclatural types, ranks, author citation, valid publication, priority of publications, name changes, synonyms, conservation and rejection of names.	Faculty-moderated), Case-Based Learning (CBL)	
IV	● Herbaria and herbarium techniques: methods plants collections and documentation; preparation and preservation of herbarium specimens, herbarium operations; virtual herbarium; major herbaria of the world and India. Functions of Herbaria. ● Botanical Survey of India: Objectives and major contributions. ● Botanic gardens: Role of Botanical Gardens in taxonomic studies; major botanical gardens of the world and India.	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL)	5,6

- **Assessment Methodologies**

(B) Internal Assessment

c. Internal Formative assessment (30 marks)

(f) **Quiz (2 quizzes):** 10 marks
(g) **Seminar:** 05 marks
(h) **Assignment**: 05 marks
(i) **Regularity:** 05 marks
(j) **Group Learning:** 05 marks

d. Internal Summative Assessment: Mid-term tests (20 marks)

(C) External Assessment: End of Term Examination (50 marks)

(C) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2	30	1	1	10	12
II	2,3,4	30	1	1	12	15
III	5,6	30	1	1	10	15
IV	5,6	30	1	1	10	08
		120	04	04	42	50

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- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO 1:	3	1	1	1	1	1	1	1	2	1	3	1
CLO 2:	1	2	2	1	2	1	2	3	3	3	1	2
CLO 3:	2	3	1	1	2	1	2	3	2	3	2	3
CLO 4:	3	1	1	1	2	1	2	2	2	2	3	1
CLO 5:	1	1	1	2	2	1	2	3	3	2	1	1
CLO 6:	1	1	1	1	1	1	-	1	1	1	1	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50%
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/ Year	Publisher
1	An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV.	Angiosperm Phylogeny Group	2016	Botanical Journal of the Linnaean Society
2	The Flora of Presidency of Bombay, Vol. I	Cook T	1903	Bishen Singh, Mahendra Pal Singh, Dehradun.
3	Plant Molecular Systematics	Crawford, D.J.	2003	Cambridge University Press,
4	An Integrated System of Classification of Flowering	Cronquist A	1981	New York: Columbia
5	Evolution and Classification of Flowering Plants	Cronquist A	1988	N Y: Botanical Garden.
6	Principles of Angiosperm Taxonomy	Davis P H and Heywood V H	1963	Oliver and Boyd

7	Angiosperm Classification and Phylogeny –Flowering Plants	Dhalgren P. M. T.	1981	Cambridge University Press,UK.
8	Pollen Morphology and Plant Taxonomy of Angiosperms (An introduction to Palynology) I	Erdtman G	1966	Hafner Pub. Co. London
9	The Cambridge Illustrated Glossary of Botanical Terms.	ckey M and King C.	2000	Cambridge University Press, UK
10	A Handbook of Field and Herbarium Methods, Today and Tomorrow	Jain S. K. and Rao R. R.	1976	Printers and Publishers, New Delhi
11	Plant Systematics	Jones S B and Luchinger A E	1986	McGraw Hill Book CO.
12	Plant Systematics – A phylogenetic approach	Judd et al.	2007	Sinauer Publication.
13	Plant Systematics: A Phylogenetic Approach	Judd, W.S., Campbell, C.S, Kellogg, E.A., Stevens, P.A. and Donoghue, M.J.	2016	Sinauer Associaes, Inc., Massachusetts.
14	Taxonomy of Vascular Plants	Lawrence G.H.M.	1951	Macmillan.
15	The Plant Book	Mabberly T J.	1997	Cambridge University Press,
16	Taxonomy of Angiosperms	Naik V. N.	1984	TMH, New Delhi.
17	Fundamentals of Plant Systematic	Radford A E.	1986	Harper and Row N Y
18	Plant Systematics	Simpson, M.G.	2010	Elsevier, Amsterdam.
19	Plant Systematics	Singh G	2004	Oxford and IBH, New Delhi.
20	Introduction to Principles of Plant Taxonomy	Sivrajan V V	1984	Oxford and IBH, New Delhi.
21	The Morphology of Angiosperms	Sporne, K. R.	1977	B. I. Publishing Pvt. Ltd.,Bombay.
22	Plant Taxonomy and Biosystematics	Stace C. A.	1980	Edward Arnold
23	Paleobotany and the Evolution of Plants	tewart, W. N. and Rathwell, G. W	1993	dge University Press.
24	Plant Taxonomy: The systematic Evaluation of Comparative Data	Stuessy, T.F.	2009	Columbia University Press, New York
25	Plant Systematics: The origin, interpretation, and ordering, of plant biodiversity	Stuessy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S.	2014	Koeltz Scientific Books, Konigstein, Germany

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- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	**Angiosperm phylogenetic group**	Angiosperm Phylogeny Group - an overview | ScienceDirect Topics
2	**Molecular Markers: An Introduction and Applications**	https://www.researchgate.net/journal/European-Journal-of-Molecular-Biotechnology

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Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBOT03	Genetics and Plant Breeding	4-0-1	120	04

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Gain fundamental knowledge about how inheritance occurs among various species.
CLO2: Apply the principles of genetics and breeding in development of new varieties of plants.
CLO3: Study the structural, analytical, and inheritance patterns of chromosomes and significance.
CLO4: Understand the mechanisms of Non-mendelian Inheritance.
CLO5: Evaluate the structural and numerical alterations of chromosomes and explain the molecular mechanisms

CLO6: Differentiate between various modes of reproduction and pollination mechanisms and evaluate breeding methodologies and genetic manipulation

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	• Fundamentals of Genetics: Mendelian analysis, Mendel's Laws of Inheritance, The principle of segregation, Test cross and back cross; The principle of Independent assortment, pedigree analysis. • Probability & Statistics in Genetics: Probability in genetic analysis; probability of combination of events, mutually exclusive events, use of binomial distribution in Genetics; The Chi-square goodness of fit test and its use in Genetics. • Interaction of genes: Incomplete dominance, co-dominance, lethal genes, epistasis, pleiotropy polygenic traits and quantitative inheritance.	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL)	01,02
II	• Chromosome: structure and nomenclature, centromere and telomere Karyotype analysis: Method, banding patterns, karyotype evolution, applications. • Sex chromosomes and sex-linked inheritance: Transmission of sex-linked traits and sex determination. • Linkage and chromosome mapping and its significance: Linkage, Crossing over- two-point crosses, three-point crosses tetrad analysis, chromosome maps.	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL)	03

III	• Maternal effects and cytoplasmic inheritance: Maternal effects in snails, Streptomycin resistance in Chlamydomonas, mitochondrial mutations in yeast, Kappa particles in paramecium, plastid inheritance in *Mirabilis jalapa*, male sterility in plants. • Alterations in chromosome number and structure: Ploidy: Aneuploidy and euploidy, polyploidy and its significance. • Alteration in chromosome structure: Deletions, duplications, inversions and translocations. • Mutations: Types of mutations, mutagens, molecular basis of mutations; transposable elements; Reverse mutations and suppressor mutations.	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL)	04
IV	• Plant Breeding: History, methods and objectives of plant breeding; Present status and future prospects; Origin, domestication and introduction of crop plants. • Modes of reproduction – asexual and sexual reproduction, determination of mode of reproduction in a species. • Modes of pollination, mechanism of pollination control, self-incompatibility, male sterility; Breeding in self-pollinated crops. • Hybridization: History, objectives and procedures in hybridization, consequences of hybridization; Polyploidy in plant breeding; application of polyploidy in crop improvement and its limitations.	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL)	5,6

- **Assessment Methodologies**

(D) Internal Assessment

e. Internal Formative assessment (30 marks)

(k) **Quiz (2 quizzes):** 10 marks
(l) **Seminar:** 05 marks
(m)**Assignment**: 05 marks
(n) **Regularity:** 05 marks
(o) **Group Learning:** 05 marks

f. Internal Summative Assessment: Mid-term tests (20 marks)

(D) External Assessment: End of Term Examination (50 marks)

(E) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	**1,2**	**30**	**1**	**1**	**10**	**12**
II	**2,3,4**	**30**	**1**	**1**	**12**	**15**

III	**5,6**	**30**	**1**	**1**	**10**	**15**
IV	**5,6**	**30**	**1**	**1**	**10**	**08**
		120	**04**	**04**	**42**	**50**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO 1	3	1	1	1	1	1	1	1	2	1	3	1
CLO 2	1	2	2	1	2	1	2	3	3	3	1	2
CLO 3	2	3	1	1	2	1	2	3	2	3	2	3
CLO 4	3	1	1	1	2	1	2	2	2	2	3	1
CLO 5	1	1	1	2	2	1	2	3	3	2	1	1
CLO 6	1	1	1	1	1	1	-	1	1	1	1	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	**3**
Moderate	**2**
Low	**1**
No correlation	**-**

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50%
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/ Year	Publisher
1	Genetics – its concepts & implications	Anna C. Pal & Helen M. Roberts	1981	Prentic – Hall Inc. Engle clifts, New Jersey. USA.
2	Principles of Genetic	Edmund W. Sinnot, L. C. Dunn & T. Dobzhansky	1984	McGraw Hill Book company Inc. New York, USA.

3	Genetics	Gupta, P. K	2000	Rastogi Publications. Shivaji Road Meerut, India.
4	Basic Genetics	Robert Weaber & Philip W. Hedrick.	1994	. W. M. C. Brown Publishers Dubuque lowq.
5	General Genetics	Sr A. M. & R. W. Owen	2022	H. Freeman & Company, Sanfrancisco.
6	Genetics	Strickberger M. W.	2015	Macmillan Publishing co. New York.
7	Principles of Plant Genetics and Breeding	George Acquaah	2012	John Wiley & Sons, Ltd
8	Handbook of Genetics and Plant Breeding	Rajendra Kumar Yadav	2021	Bhavya Books
9	Plant Breeding	Dr. Pratik Satya	2024	Book and allied Pvt.Ltd.
10	A text book of Plant breeding	B.D. Singh	2015	Kalyani publication, Ludhiana.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Asymmetric selection of a rice immune module and rebuild of disease resistance	**https://www.nature.com/articles/s41586-026-10361-6**
2	Plant-based protein crops and their improvement: Current status and future perspectives	**https://doi.org/10.1002/csc2.21389**
3	Breeding and genetics of resistance to major diseases in *Cucurbita*—A review	**https://doi.org/10.1002/csc2.21358**
4	Multi-omics analysis reveals the genetic basis of rice fragrance mediated by *betaine aldehyde dehydrogenase 2*	**https://doi.org/10.1016/j.jare.2021.12.004**

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Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBOT04	Plant Cytogenetics and Quantitative Genetics Techniques	0-8-0	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Prepare cytological materials using appropriate stains, fixatives, and pretreatments for microscopic analysis.

CLO2: Analyze chromosome structure and organization through karyotyping, banding techniques, and somatic metaphase preparation.

CLO3: Interpret meiotic behavior and chromosomal aberrations to understand genetic stability and variation.

CLO4: Apply principles of Mendelian genetics, linkage, population genetics, and pedigree analysis to solve genetic problems.

CLO5: Evaluate experimental data using statistical tools such as binomial probability and chi-square analysis.

CLO6: Demonstrate practical skills in plant reproductive biology and genetic manipulation, including pollen viability assessment and induction of polyploidy.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	1. Preparation of stains, Fixatives, preservatives and pretreatments to plant material 2. Karyotype analysis, preparation of somatic C- metaphase chromosomes of appropriate material and Karyotype analysis in Allium/Aloe. 3. Study of meiotic configuration in maize/ Allium, Rhoe/Aloe, Tradescantia (prophase I, chiasma analysis). 4. Study of chromosomal aberrations in irradiated plant material 5. Problems of Mendelian inheritance and estimation of gene frequencies and heterozygotic frequencies, population genetics and Linkage. 6. Pedigree analysis – problems on pedigree analysis to establish autosomal/sex-linked dominance and recessive transmission in humans 7. Problems related to probabilities by using binomial and chi-square analysis	Interactive lectures Experiential learning Problem Based Learning Collaborative Learning	1 to 5

	8. Linear differentiation of chromosomes through banding techniques such as C Banding, G-Banding and Q-Banding. 9. Floral Biology, study of Pollen Viability, germination in vitro and staining of any two major crops. 10. Use of Colchicine for induction of polyploidy in appropriate plant material.		

- **Assessment Methodologies**

(A) Internal Assessment (50 marks)

a. Internal Formative assessment (30 marks)

(a) Regularity :05 marks
(b) Performance in Laboratory: 05 marks
(c) Laboratory Record: 05
(d) Group Learning: 05
(e) Spotting/Quiz: 05
(f) Viva Voce: 05

b. Internal Summative Assessment

Problem based learning: 20

(B) External Assessment: 50 marks

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
	1 to 5	120	10	10	30	50

- **CLOs – PLOs Matrix**

CLO/ PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	1	1	3	1	1	-	1	1	1	2
CLO2	3	3	2	2	3	2	1	1	1	1	1	2
CLO3	2	3	3	3	2	2	1	-	1	1	1	2
CLO4	3	3	3	3	2	3	2	1	1	1	1	2
CLO5	2	3	3	3	2	3	2	1	1	1	1	2
CLO6	2	2	2	2	3	2	2	-	1	2	1	2

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Master of Science in BOTANY (Semester-II)

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Laboratory Performance, Laboratory Records, Team work, Viva Voce Regularity, Problem Solving.	50%
2	End-Semester Examination	Practical Exam (Approach, Performance, Interpretation and Spots/Viva)	50%

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Genetics – its concepts & implications	Anna C. Pal & Helen M. Roberts	1981	Prentic – Hall Inc. Engle clifts, New Jersey. USA.
2	Principles of Genetics	Edmund W. Sinnot, L. C. Dunn & T. Dobzhansky	1984	McGraw Hill Book company Inc. New York, USA.
3	Genetics	Gupta, P. K	2000	Rastogi Publications. Shivaji Road Meerut, India.
4	Basic Genetics	Robert Weaber & Philip W. Hedrick.	1994	. W. M. C. Brown Publishers Dubuque lowq.
5	General Genetics	Sr A. M. & R. W. Owen	2022	W. H. Freeman & Company, Sanfrancisco.
6	Genetics	Strickberger M. W.	2015	Macmillan Publishing co. New York.

7	Principles of Plant Genetics and Breeding	George Acquaah	2012	John Wiley & Sons, Ltd
8	Handbook of Genetics and Plant Breeding	Rajendra Kumar Yadav	2021	Bhavya Books

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	**Online Course Plant Breeding**	**https://www.wur.nl/en/education/for-professionals/programmes-and-courses/online-course-plant-breeding**
2	**Plant Breeding | Plant Genetics | Online Course**	**https://www.acsedu.co.uk/courses/general-horticulture/plant-breeding-bht236-529.aspx**
3	**UNL launches online plant breeding and genetics**	**https://newsroom.unl.edu/announce/iannews/1367/7890**

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBOT05	Systematics and Biotic Interactions	0-8-0	**120**	04

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Identify and classify plants and fungi using morphological, anatomical, and microscopic characteristics.

CLO2: Apply taxonomic tools such as identification keys, floras, herbarium techniques, and dendrogram construction for plant systematics.

CLO3: Isolate, culture, and characterize fungi using standard microbiological and staining techniques.

CLO4: Analyze plant diseases and interpret plant–pathogen interactions using microscopic and experimental approaches.

CLO5: Evaluate biological data (e.g., similarity indices, disease index, molecular markers) to draw scientific conclusions.

CLO6: Demonstrate scientific communication skills through field reports, herbarium preparation, diagrams, and viva voce.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	1. Observation of permanent slides of various fungi. 2. Semi-permanent slide preparation, staining and identification of fungi. 3. Study of fungal morphology using LPCB staining 4. Identification of common fungi from cultures 5. Study of fungal reproductive structures 6. Preparation of microbial culture media 7. Demonstration of Koch's postulates (basic level) 8. Study of various diseased plant material and identification. (Leaf blight, canker, leaf spot, Mosaic, panama and leaf curl diseases). 9. Microscopic observation of infected plant tissues 10. Estimation of disease severity using disease index 11. Antifungal activity assay using plant extracts 12. Study of mycorrhizal association in plant roots 13. Description of specimens from locally available representative families. 14. Description of a genus based on 3-4 different species.	Interactive lectures Experiential learning Problem Based Learning Collaborative Learning	1 to 5

	15. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients. 16. Identification of plant specimens using floras and identification keys. 17. Preparation of identification keys for at least 10 specimens based on morphological features. 18. Study of herbarium specimens of different families covered in theory course. 19. Field trips; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant. 20. Use of palynological, chemical methods in taxonomy. 21. Use of molecular markers to determine genetic relatedness between species. 22. Construction of dendrograms using appropriate software.		

- **Assessment Methodologies**

(C) Internal Assessment (50 marks)

c. Internal Formative assessment (30 marks)

(g) Regularity :05 marks

(h) Performance in Laboratory: 05 marks

(i) Laboratory Record: 05

(j) Group Learning: 05

(k) Spotting/Quiz: 05

(l) Viva Voce: 05

d. Internal Summative Assessment

Problem based learning: 20

(D) External Assessment: 50 marks

(C) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
	1 to 5	120	10	10	30	50

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- **CLOs – PLOs Matrix**

CLO / PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	1	1	2	1	1	-	-	2	1	2
CLO2	3	3	2	2	2	2	1	2	-	2	1	2
CLO3	2	3	2	3	3	2	1	-	1	1	1	2
CLO4	2	3	3	3	3	3	2	-	1	2	1	2
CLO5	2	3	3	3	2	3	2	2	1	2	1	2
CLO6	1	2	1	1	1	2	3	1	2	1	2	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage(%)
1	Continuous Internal Evaluation	Laboratory Performance, Laboratory Records, Team work, Viva Voce Regularity, Problem Solving.	50%
2	End-Semester Examination	Practical Exam (Approach, Performance, Interpretation and Spots/Viva)	50%

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Introductory Mycology	Alexopoulos et al.		Wiley
2	An Introduction to Fungi	H.C. Dube		Scientific Publishers
3	Principles of Plant Pathology	R.S. Singh		Oxford & IBH
4	Plant Diseases	R.S. Singh		Oxford & IBH

5	Plant Pathology	Agrios		Elsevier
6	Taxonomy of Vascular Plants	Lawrence G. H. M.	1951	Macmillan.
7	Taxonomy of Angiosperms	Naik V. N.	1984	TMH, New Delhi.
8	Plant Systematics	Singh G	2004	Oxford and IBH, New Delhi.
9	Plant Taxonomy and Biosystematics	Stace C. A.	1980	Edward Arnold
10	Plant Taxonomy: The systematic Evaluation of Comparative Data	Stuessy, T.F.	2009	Columbia University Press, New York

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Angiosperm phylogenetic group	Angiosperm Phylogeny Group - an overview | ScienceDirect Topics
2	Molecular Markers: An Introduction and Applications	https://www.researchgate.net/journal/European-Journal-of-Molecular-Biotechnology
3	General Microbiology	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec19_bt11
4	Mushroom Production	https://onlinecourses.swayam2.ac.in/e-learning/preview/nos20_ge07
5	Plant Pathology and Soil Health	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec25_bt06
6	Diseases of horticultural crop	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec20_ag11

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Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEBOT01	Biostatistics Using R	0-4-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

CLO1: Demonstrate proficiency in R programming for biological data manipulation, cleaning, and preprocessing.

CLO2: Construct advanced biological visualizations including bar plots with error bars, box plots, and violin plots to represent data variability.

CLO3: Apply and interpret parametric and non-parametric tests appropriate for specific experimental designs in life sciences.

CLO4: Execute and validate regression models (simple, multiple, and logistic) for biological prediction and association studies.

CLO5: Effectively communicate statistical findings using professional-grade R outputs and comprehensive analysis pipelines.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Introduction to R Environment:** Data Visualization in Bioscience I: scatter plots, box plots, bar graphs with error bars, aesthetics, axis labelling, legends, and theme customization. Data Visualization in Bioscience II: Heat maps using heatmap or Complex Heatmap packages, Violin plots t-Test: One sample, two sample, paired t-test One-Way ANOVA: Checking Assumptions using visualization methods and tests Post-Hoc Analysis for ANOVA Categorical Data Analysis: Test of proportion, Chi-square test Association etc.	Classroom Lectures, Case Based Learning, Problem Based Learning, Micro-Projects,	1,2,3

II	**Non-Parametric Alternatives I:** Wilcoxon Signed-Rank Test and Mann-Whitney U Test as Alternatives to t-Tests Non-Parametric Alternatives II: Kruskal-Wallis Test and Dunn's Post-Hoc Test as Alternatives to One-Way ANOVA Simple Linear Regression: Multiple Regression: Logistic Regression: Case Study	Micro-Projects, ICT-Enable Learning, Classroom Lectures, Case Based Learning, Problem Based Learning	3,4,5

- **Assessment Methodologies**

(A) Internal Assessment

a. **Internal Formative assessment (15 marks)**
   (a) **Quiz: 05 marks**
   (b) **Class Regularity: 05 marks**
   (c) **Group Learning/ ssignment: 05 marks**
b. **Internal Summative Assessment (10 marks)**

(B) End of Term Examination: 25 marks

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2,3	30	02	02	07	11
II	3,4,5	30	03	03	08	14
		60	**05**	**05**	**15**	**25**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	2	2	1	3	3	2	2	3	1	–	1	2
CLO 2:	2	1	–	2	3	2	2	3	3	–	1	1
CLO 3:	2	2	1	2	2	3	3	3	2	1	1	2
CLO 4:	2	1	1	2	3	3	3	3	2	1	1	2
CLO 5:	1	1	2	2	3	2	2	2	3	1	2	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50
2	End-Semester Examination	Written Exam	50

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Master of Science in BOTANY (Semester-II)

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Dalgaard, P.	Introductory Statistics with R	2008	Springer Science & Business Media
2	Logan, M.	Biostatistical Design and Analysis Using R: A Practical Guide	2010	Wiley-Blackwell.
3	Zar, J. H.	Biostatistical Analysis	2010	Pearson Education

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Free textbook	https://learningstatisticswithr.com/
2	R for Data Science: Online textbook	**https://r4ds.hadley.nz/**
3	Modern Statistics with R: Online textbook	**https://www.modernstatisticswithr.com/**
4	simpleR – Using R for Introductory Statistics: Online textbook	**https://cran.r-project.org/doc/contrib/Verzani-SimpleR.pdf**
5	Swirl: Interactive R package learning resource	**https://swirlstats.com/**
6	Cloud based hands on tutorials	**https://posit.cloud/learn/recipes**
7	Harvard University's "Statistics and R"	**https://pll.harvard.edu/course/statistics-and-r**

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Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEBOT02	Microtechniques	1-2-0	**60**	02

Course Learning Outcomes (CLOs):

On completion of this course, students will be able to:

CLO1: Explain principles and procedures of sample preparation techniques such as maceration, squash, and clearing for microscopic analysis.

CLO2: Perform fixation, dehydration, infiltration, embedding, and staining methods used in light microscopy and evaluate their significance in tissue preservation.

CLO3: Apply microtomy techniques using rotary, sliding, and cryostat microtomes for sectioning biological specimens.

CLO4: Analyze histochemical localization of cellular components such as carbohydrates, proteins, lipids, lignin, and nucleic acids in plant tissues.

CLO5: Apply principles and procedures involved in electron microscopy sample preparation including fixation, ultrathin sectioning, staining, and grid preparation.

CLO6: Analyze ultrastructural cytochemistry and enzyme localization techniques, including immunocytochemistry, for advanced cellular studies.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	• **Techniques in Light Microscopy** • Maceration, squash and clearing techniques. • Sample preparation for light microscopy. • Classification of fixatives, formulas (Plants). • Processing samples for light microscopy: Fixation, dehydration, infiltration, embedding media, staining (Stains and staining procedures- negative and positive staining procedures). • Microtomes: Rotary, sliding, cryostat. • Histochemical localization of metabolites for light microscopy: Starch, proteins, lipids, total carbohydrates, lignins, polyphenols, nucleic acid, histones, cutin, suberin and waxes. • Localization of enzymes: Peroxidase, acid phosphatase and succinic dehydrogenase.	Classroom Lecture, Seminars, Case-Based Learning, Experiential Learning, ICT-Enabled Learning, Self-Directed Learning	01, 02, 03, 04
II	• **Techniques in Electron Microscopy** • Freeze etching and freeze fracturing.	Classroom Lecture, Seminars,	05, 06

	• Sample preparation for Electron microscope: Fixatives, double fixation, dehydration and infiltration, embedding media and embedding, sectioning (semi thin sectioning, ultrathin sectioning), grids, formvar coating, Staining for electron microscopy. • Fixation and embedding of particulate samples like bacteria, virus etc. • Operations of ultramicrotome and freezing ultramicrotome. • Ultrastructural cytochemistry: Tannin, protein, cell wall polysaccharide, lignin and membrane. • Ultrastructural cytochemistry: Enzymes: Peroxidase and phosphatase. • Immunocytochemistry.	Case-Based Learning, Research-Oriented Learning, Experiential Learning, ICT-Enabled Learning	

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (15 marks)

(a) Quiz: 05 marks

(b) Seminar: 05 marks

(c) Group Learning/Assignment: 05 marks

b. Internal Summative Assessment (10 marks)

(B) End of Term Examination: 25 marks

(B) Weightage of Learning Efforts for Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1, 2, 3, 4	30	8	10	7	25
II	5, 6	30	6	8	11	25
		60 (4Hr/week)	14	18	18	50

- **CLOs – PLOs Matrix**

CLO / PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	2	1	2	1	1	2	1	1	1	1
CLO2	3	2	2	1	3	1	1	2	1	1	1	1
CLO3	2	2	3	1	3	1	1	3	1	1	1	1
CLO4	2	3	3	1	3	1	1	3	2	1	1	1
CLO5	2	2	3	1	3	1	1	3	2	1	1	1
CLO6	2	3	3	2	3	1	1	3	2	2	1	2

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Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50%
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/ Year	Publisher
1	Microscopy and Microtechnique	R. Marimuthu	2017	MJP Publishers
2	Plant Microtechnique	Johansen	1940	McGraw-Hill Inc., USA
3	Botanical Microtechnique and Cytochemistry	Berlyn	1976	Wiley–Blackwell, USA
4	Study of Plant Structure	O'Brien & McCully	1969	Termarcarphi Pty. Ltd. in Melbourne, Australia.
5	Botanical Microtechniques: Principle and practice	S. M. Khasim	2002	Capital Publishing Company

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	**Transmission Electron Microscopy**	https://nptel.ac.in/courses/113106924
2	**Fundamentals of Cryo-Electron Microscopy**	https://nptel.ac.in/courses/102108668
3	**Lecture 34: Electron Microscopy-I**	https://archive.nptel.ac.in/content/storage2/courses/102103047/module6/lec34/1.html

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Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEBOT03	Developmental Biology	2-0-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

CLO1: Understand key concepts of Developmental Biology including cell fate, induction, and differentiation in plants and animals.

CLO2: Explain gametogenesis, fertilization, and early embryonic development along with underlying molecular mechanisms.

CLO3: Analyze morphogenesis and organogenesis using model organisms like *Drosophila melanogaster* and *Caenorhabditis elegans.*

CLO4: Apply developmental principles to plant systems including embryogenesis, seed formation, and environmental regulation.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Basic concepts of Development, fertilization and early development Induction, competence, induction, specification, determination, differentiation, dedifferentiation, redifferentiation; Fate maps, cell fate, cell lineages; Stem cells: potency, genomic equivalence, cytoplasmic determinants Gametogenesis: spermatogenesis and oogenesis-structure and function of gametes; Fertilization: mechanisms, sperm-egg interaction, egg activation; Molecular basis of development; development of germ layers in animals Male gametophyte development, embryo sac development and double fertilization in plants, embryogenesis, establishment of symmetry in plants, seed formation, embryo and endosperm developmental dynamics and germination	Classroom Lecture Case-Based Learning Problem-Based Learning Inquiry-Based Learning ICT-Enabled Learning Reflective Practices Self-Directed Learning Research-Oriented Learning	1,2
II	Morphogenesis and organogenesis in plants and animals Organization of shoot and root apical meristem, shoot and root development, leaf development and phyllotaxy, transition to flowering, floral meristems, organogenesis and floral development Cell aggregation and differentiation in Dictyostelium, axes and pattern formation in Drosophila, amphibia and chick; organogenesis - vulva formation in *Caenorhabditis elegans*, eye	Classroom Lecture Case-Based Learning Seminar Problem-Based Learning Inquiry-Based Learning	3,4

	lens induction, limb development and regeneration in vertebrates, differentiation of neurons, post embryonic development - larval formation, metamorphosis; environmental regulation of normal development; sex determination	ICT-Enabled Learning Micro Project Reflective Practices Self-Directed Learning Research-Oriented Learning	

- **Assessment Methodologies**

(A) Internal Assessment

a. **Internal Formative assessment (15 marks)**
   (a) **Quiz: 05 marks**
   (b) **Seminar: 05 marks**
   (c) **Group Learning/Assignment: 05 marks**
b. **Internal Summative Assessment (10 marks)**

(B) End of Term Examination: 25 marks

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2	30	02	04	06	12
II	3,4	30	02	04	07	13
		60	04	08	13	25

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	–	–	2	2	–	2	–	1	–	–	1
CLO 2:	3	2	–	2	2	–	2	1	1	–	–	1
CLO 3:	3	2	–	2	3	1	3	2	1	–	1	2
CLO 4:	3	2	–	2	3	2	3	2	1	2	1	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

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- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50
2	End-Semester Examination	Written Exam	50

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Developmental Biology	Scott F. Gilbert & Michael J.F. Barresi	13th Ed. (2023)	Oxford University Press
2	Principles of Development	Lewis Wolpert et al.	6th Ed. (2019/20)	Oxford University Press
3	Essential Developmental Biology	Jonathan Slack	4th Ed. (2021)	Wiley-Blackwell
4	Langman's Medical Embryology	T.W. Sadler	15th Ed. (2023)	Wolters Kluwer
5	Analysis of Biological Development	Klaus Kalthoff	2nd Ed. (2000)	McGraw-Hill

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Introduction to Developmental Biology	https://nptel.ac.in/courses/102106084

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Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	P2S02NEBOT04	Methods in Field Biology	1-2-0	60	02

On completing the course, the students will be able to:

CLO1 **Analyze and justify** the selection of appropriate scientific sampling strategies and field techniques for reliable biological data collection.

CLO2 **Critically analyze and interpret** field data using statistical tools to derive meaningful biological inferences.

CLO3 **Evaluate and optimize** the use of digital tools and standardized formats for accurate data management, analysis, and visualization.

CLO4 **Design, execute, and critically evaluate** a field-based research study, integrating ethical considerations and scientific rigor.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Sampling Design, Field Techniques and Data Types: Principles of sampling design: random, stratified, systematic; Field sampling techniques: transect, quadrat, point count; Sampling of mobile vs sessile organisms; Marking and tracking methods: tagging, banding, QR coding; Mark–recapture method *(N = MC/R)*; Types of biological data: qualitative vs quantitative; Sources of sampling error and bias	Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	1
II	Data Handling, Basic Statistics and Visualization: Data entry, coding, and tabulation; Use of spreadsheets (Excel/basic tools); Descriptive statistics: mean, median, mode, standard deviation; Graphical representation: bar charts, histograms, line graphs; Introduction to GIS (data visualization only); Concept of hypothesis testing; t-test; Interpretation of statistical outputs in field context; Case based practice with sample datasets and graph preparation	Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	2, 3

III	Research Design, Mini Project and Data Interpretation: Research design in field biology: Problem identification, Hypothesis formulation, Site and species selection; Observational vs experimental studies, Basic data interpretation and inference; Scientific Report writing; Ethical guidelines and legal permissions; Risk assessment and safety protocols	Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	3,4

- **Assessment Methodologies**

(A) Internal Assessment

c. Internal Formative assessment (15 marks)

(d) Quiz: 05 marks
(e) Seminar: 05 marks
(f) Group Learning/ Assignment: 05 marks

d. Internal Summative Assessment (10 marks)

(B) End of Term Examination: 25 marks

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1	20	1	1	6	08
II	2,3	20	1	1	6	08
III	3,4	20	1	1	7	09
		30	03	03	19	25

CLO-PLO Matrix:

CLOs / PLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO 1:	2	3	1	1	2	2	3	3	1	1	2	2
CLO 2:	2	2	1	2	3	3	3	3	2	1	1	2
CLO 3:	1	2	1	3	3	2	2	3	3	1	1	2
CLO 4:	3	3	3	2	2	3	3	3	2	2	2	3

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Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Examination	100

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Measuring Biological Diversity	Anne E. Magurran	2004	Blackwell Publishing
2	Ecological Methodology	Charles J. Krebs	2nd, 2014	Benjamin Cummings
3	Biostatistical Analysis	Jerrold H. Zar	5th, 2010	Pearson
4	Sampling Methods for Ecology	T.R.E. Southwood & P.A. Henderson	3rd, 2000	Blackwell Science
5				

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	**National Ecological Observatory Network**	**https://www.neonscience.org/**

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science in BOTANY (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEBOT05	Medical Botany	2-0-1	**60**	02

Course Learning Outcomes (CLOs):

On completion of this course, students will be able to:

CLO1: Explain the role of plants as sources of drugs, pharmaceuticals, and pharmaceutical aids, and assess their importance in healthcare systems.

CLO2: Describe principles, methods, and approaches of ethnomedico-botany, including documentation, validation, and preservation of traditional knowledge.

CLO3: Apply field-based techniques for collection, verification, and documentation of ethnomedicinal data, including preparation of voucher specimens and herbarium analysis.

CLO4: Analyze pharmacognostic characteristics and chemical nature of plant-derived drugs such as alkaloids, glycosides, volatile oils, tannins, and resins.

CLO5: Interpret the structure, biosynthesis, and functional roles of major plant secondary metabolites including phenolics, alkaloids, steroids, and natural antibiotics.

CLO6: Evaluate methods for screening plant materials for bioactive compounds and assess their potential applications in drug discovery and development.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	● **Fundamentals of Medical Botany, Ethnobotany and Modern Applications** ● Introduction to medical botany: scope, history, and significance. ● Plants as sources of drugs, pharmaceuticals and pharmaceutical aids. ● Ethnomedicobotany: Basic approaches to study traditional knowledge on herbal medicine; Scope and potential applications. ● Collection methods of ethnomedicobotanical data: Field methods and scrutiny of Herbarium specimens and folklore; verification of data; collection of materials for voucher specimen and for phytochemical screening; application of ethnomedicobotany. ● Creating indigenous knowledge base of traditional medicines of plant origin	Classroom Lecture, Seminars, Case-Based Learning, Industrial Visit/Field Visit/Institutional Visit, ICT-Enabled Learning, Self-Directed Learning	01,02, 03
II	● **Medicinal Plants and Phytochemistry** ● Pharmacognosy of drugs derived from alkaloids, glycosides, volatile oils, lipids, gums, resins, tannins and saponins.	Classroom Lecture, Seminars,	04, 05, 06

	● Drugs of botanical origin: Structure, physical properties, biosynthesis and chemistry of secondary metabolites: phenols, phenolic glycosides, saponins, steroids, alkaloids, vitamins and hormones and natural antibiotics. ● Methods for screening natural sources for bioactive principles. ● Secondary metabolites: Major pathways, structure and biosynthesis of plant pigments, alkaloids, glycosides and lignin.	Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning	

- **Assessment Methodologies**

(C) Internal Assessment

c. Internal Formative assessment (15 marks)

(d) Quiz: 05 marks

(e) Seminar: 05 marks

(f) Group Learning/Assignment: 05 marks

d. Internal Summative Assessment (10 marks)

(D) End of Term Examination: 25 marks

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1, 2, 3	30	2	4	19	25
II	4, 5, 6	30	2	4	19	25
		60	04	08	38	50

- **CLOs – PLOs Matrix**

CLO / PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	1	1	1	2	1	1	2	1	1	1
CLO2	2	3	2	2	1	3	2	1	2	1	1	2
CLO3	2	2	3	2	2	3	2	2	2	1	1	2
CLO4	3	2	3	1	3	2	1	2	3	1	1	2
CLO5	3	3	2	1	2	2	1	3	3	2	1	2
CLO6	2	3	3	2	2	3	1	3	3	2	1	3

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Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50%
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/ Year	Publisher
1	Pharmacognosy	Kokate, Purohit & Gokhale	21st Ed. 2002	Nirali Prakashan, Pune, 377-378.
2	Economic Botany	B.P. Pandey	1999	S. Chand
3	Medicinal Plants	K.R. Kirtikar & Basu	1935	Lalit Mohan Publication, Allahabad, 1347-1348
4	Plant Secondary Metabolism	Taiz & Zeiger	2006	Sinauer Associates, Inc., Sunderland
5	Ethnobotany	S.K. Jain	1995/2004	Scientific Publishers, Jodhpur, 1-11.

- **Online Resources (Open Source)**

Sr.No.	Description of Resource(s)	Weblink
1	**Pharmacognosy & Metabolic Engineering**	**https://onlinecourses.nptel.ac.in/noc26_bt28/preview**
2	**Pharmacognosy and Phytochemistry**	**https://onlinecourses.nptel.ac.in/noc25_ch102/preview**
3	**Herbal Product Technology and Regulatory Science**	**https://onlinecourses.nptel.ac.in/noc26_ch02/preview**
4	**Indian Traditional Medicinal and Aromatic Plants**	**https://onlinecourses.swayam2.ac.in/e-learning/preview/aic23_ge18**