# 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-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSC | P2S01NCBOT01 | Biology and Diversity of Lower Plants | 4-0-1 | **120** | 04 |

**Course Learning Outcomes (CLOs):**

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

**CLO1: Explain** the diversity, structure, nutrition, and reproduction of prokaryotic organisms including archaebacteria, eubacteria, and cyanobacteria, and assess their ecological significance.

**CLO2: Describe** the diversity, classification, thallus organization, and reproductive strategies of algae, and interpret their ecological roles and economic importance.

**CLO3: Analyse** the morphology, anatomy, reproduction, and life cycles of bryophytes, and evaluate their evolutionary significance and ecological adaptations.

**CLO4: Explain** the structural organization, reproductive biology, and classification of pteridophytes, including fossil groups, and assess their evolutionary trends.

**CLO5: Interpret** evolutionary progression among lower plant groups with special reference to heterospory, origin of seed habit, and vascular system evolution.

**CLO6: Evaluate** the ecological and economic importance of lower plants and apply this knowledge in environmental and applied biological contexts.

| Unit | Course Content | Learning Pedagogies* | CO(s) |
|---|---|---|---|
| I | • **Archaebacteria and eubacteria —** General account, and classification; ultra-structure, mode of nutrition and reproduction biology and economic importance<br>• **Cyanobacteria** – Cell Ultrastructure, ecological importance, Reproduction and life cycles, Symbiotic associations | Classroom Lecture (CL), Seminars, ICT-Enabled Learning | 01,02 |
| II | **Phycology:**<br>• Algae in diversified habits (terrestrial, freshwater, marine); thallus organization; cell ultra-structure; reproduction (vegetative, asexual, sexual)<br>• Classification of algae (including Criteria for classification: pigments, reserve food, flagella); Algal phylogeny (molecular insights)<br>• Salient features of Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta<br>• Ecological and economical importance and algal blooms. | Classroom Lecture (CL), Seminars, Collaborative Learning, ICT-Enabled Learning | 03 |

## Master of Science in BOTANY (Semester-I)

| | | | |
|---|---|---|---|
| III | **Bryophyta:**<br>● Morphology, Structure, reproduction biology and alternation of generations, Evolutionary significance and Evolution of sporophyte.<br>● Distribution; Classification; General account of Marchantiales; Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.<br>● Economic and Ecological Importance, Bryophytes as bioindicators. | Classroom Lecture (CL), Seminars, Field Visit, Collaborative Learning, ICT-Enabled Learning | 04 |
| IV | **Pteridophyta:**<br>● Morphology, Anatomy and Reproduction Biology<br>● Classification of Pteridophyta<br>● Origin and life cycle of Pteridophyta; Evolution of sporophyll; Organization and evolution of stele (vascular elements); Heterospory and Origin of Seed habit<br>● General account of fossil Pteridophyta; Psilopsida, Lycopsida, Sphenopsida and Pteropsida. | Classroom Lecture (CL), Seminars, Field Visit, Collaborative Learning, ICT-Enabled 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 | 2 | 3 | 5 | 10 |
| II | 3 | 30 | 3 | 4 | 6 | 13 |
| III | 4 | 30 | 3 | 4 | 6 | 13 |
| IV | 5, 6 | 30 | 4 | 4 | 6 | 14 |
| | | 120 | 12 | 15 | 23 | 50 |

- **CLOs–PLOs Matrix**

| CLO/PLO | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CLO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| CLO3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| CLO4 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| CLO5 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 |
| CLO6 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 2 | 3 | 2 | 1 | 2 |

## Master of Science in BOTANY (Semester-I)

Values to the **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:**

## Master of Science in BOTANY (Semester-I)

| Sr.No. | Title | Author(s) | Edition / Year | Publisher |
|---|---|---|---|---|
| 1 | Introductory Phycology. | Kumar, H. D. | 1999 | Affiliated East - West Press Ltd., New Delhi |
| 2 | The Biology of Algae | Round, F. E. | 1976 | Cambridge University Press, Cambridge. |
| 3 | Bryophyta. | Parihar, N. S. | 5th Ed. 2013 | Central Book Depot, Allahabad. |
| 4 | Cryptogamic Botany (Vol. II) Bryophytes and Pteridophytes. | Smith, G. M. | 2nd Ed. 2021 | McGraw- Hill. |
| 5 | The Morphology of Pteridophytes. | Sporne, K. R. | 2nd 2022 | B. I. Publishing Pvt. Ltd., Bombay. |
| 6 | Palaeobotany and the Evolution of Plants. | Stewart, W. N. and Rathwell, G. W. | 2nd 1993 | Cambridge University Press. |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | Lecture 2: Archaea and Bacteria | https://archive.nptel.ac.in/content/storage2/courses/102103015/module8/lec2/5.html |
| 2 | Lecture 51: Introduction to Algal Biomass | http://digimat.in/nptel/courses/video/103105680/L51.html |
| 3 | Plant groups (Plant Diversity) | https://onlinecourses.swayam2.ac.in/e-learning/preview/cec22_bt19 |
| 4 | Lecture 2: Classification of Living Organisms | https://archive.nptel.ac.in/content/storage2/courses/122103039/module1/lec2/4.html |

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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-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSC | P2S01NCBOT02 | Biology and Diversity of Seed Plants | 4-0-1 | **120** | **04** |

**Course Learning Outcomes (CLOs):**

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

**CLO1:** Understand the evolution of seed plants over the lower plants.

**CLO2:** Analyze evolutionary trends of gymnosperms and classification.

**CLO3:** Analyze advancement in life cycles of seed plants over the lower plants.

**CLO4:** Recognize and identify the diversity and differences among various families of gymnosperms and angiosperms

**CLO5:** Demonstrate the linkages of floral diversity with pollinators.

**CLO6:** Understand evolutionary trend in seed plants

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | • Characteristics of seed plants; evolution of the seed habit; seed plants with (angiosperms) and without (gymnosperms) fruits; fossil and living seed plants.<br>• General features of gymnosperms and their classification; evolution and diversity of gymnosperms and their distribution in India. | Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL) | 1, 2 |
| II | • Geological time scale, fossilization and fossil gymnosperms: Pteridospermales<br>• Morphology of vegetative and reproductive parts; anatomy of root, stem and leaf; reproduction and life cycle of Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales. | Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL) | 1, 2, 3 |
| III | • Origin and evolution of Angiosperms; primitive and fossil angiosperms; advance features of angiosperms.<br>• Morphological and anatomical diversity of vegetative parts of angiosperms. | Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Case-Based Learning (CBL) | 1,3,4 |

| | | | |
|---|---|---|---|
| IV | • Origin and evolution of flower.<br>• Diversity in floral morphology; evolution of inflorescence patterns.<br>• Origin and evolution of ploypetaly, sympetaly, apetaly, monoecy, dioecy; co-evolution of flower vis-à-vis pollinators.<br>• Origin and evolution of stamens and carpels. | 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)**

**(B)External Assessment: End of Term Examination (50 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 | 1,2 | 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**

| 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 |
| CLO2 | 3 | 1 | – | 2 | 1 | 1 | 2 | – | – | – | – | 1 |
| CLO3 | 3 | – | – | 2 | – | 1 | 2 | – | – | – | – | 1 |

## Master of Science in BOTANY (Semester-I)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLO4** | **3** | **2** | **–** | **1** | **1** | **1** | **2** | **1** | **–** | **1** | **–** | **1** |
| **CLO5** | **3** | **1** | **–** | **2** | **2** | **2** | **2** | **1** | **1** | **2** | **–** | **1** |
| **CLO6** | **3** | **–** | **–** | **2** | **1** | **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, Class Regularity, | 50% |
| 2 | End-Semester Examination | Written Exam/Practical Exam<br>Project Evaluation<br>(Report, Presentation, Viva) | 50% |

- **Suggested Learning Materials Books:**

| Sr. No. | Title | Author(s) | Edition /Year | Publisher |
|---|---|---|---|---|
| 1 | An Introduction to Palaeobotany | Arnold C. A. | 1972 | McGraw Hill Book Company Inc. |
| 2 | Gymnosperms | Bhatnagar,S.P. and Moitra, A. | 1996 | New Age International Pvt.Ltd. New Delhi. |
| 3 | Gymnosperms-Structure and Evolution | Chamberlein C.J | 1966 | University of Chicago Press |
| 4 | Plant anatomy | Cutter E.G | 1971 | London; E. Arnold |
| 5 | Morphology of Gymnosperms | Cutter E.G and Chamberlein C.J | 1978 | University of Chicago Press |
| 6 | Morphology of Angiosperms | Eames A J | 1961 | McGraw Hill Book Co |
| 7 | Plant Anatomy – Anatomy of Seed Plants | Easu K | 1962 | Wiely, New York |
| 8 | Plant Anatomy. | Fahan A. | 1969 | Oxford press; New York : |

## Master of Science in BOTANY (Semester-I)

| | | | | |
|---|---|---|---|---|
| 9 | Comparative Morphology of Vascular Plants. | Foster A. S. and Gifford E. M. | 1959 | San Francisco, W.H. Freeman |
| 10 | Anatomy of the Dicotyledons | Metcalfe C. R. and L. Chalk | 1950 | Oxford At The Clarendon Press. |
| 11 | Essentials of Palaeobotany | Shukla A. C. and Mishra S. D. | 1975 | Vikas Publisher. |
| 12 | The Morphology of gymnosperms | Sporne, K. R. | 1967 | B. I. Publishing Pvt. Ltd., Bombay |
| 13 | Morphology of Angiosperms | Sporne K R | 1974 | Hutchinson University Library, London. |
| 14 | Aquatic angiosperms | Subrahmanyam K | 2024 | BSI. India |
| 15 | Gymnosperms | Vashistha P. C. | 1976 | Chand and Company. |
| 16 | Paleobotany and the Evolution of Plants | Stewart, W. N. and Rathwell, G. W. | 2005 | Cambridge University Press. |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | The Systematics and Evolution of Gymnosperms with an Emphasis on a Few Problematic Taxa | https://doi.org/10.3390/plants13162196 |
| 2 | Palaeobotany and Global Change: Important Lessons for Species to Biomes from Vegetation Responses to Past Global Change | https://doi.org/10.1146/annurev-arplant-042817-040405 |
| 3 | Anatomy of Flowering Plants: An Introduction to Structure and Development | https://doi.org/10.1017/CBO9780511801709 |
| 4 | Anatomy of the Primary Vascular System in Dicotyledonous Plants | https://www.nature.com/articles/158737a0#citeas |

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

## Master of Science in BOTANY (Semester-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSC | P2S01NCBOT03 | Cell and Molecular Biology | 4-0-1 | **120** | 04 |

**Course Learning Outcomes (CLOs):**

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

CLO1: **Explain** the structural organization and functional significance of prokaryotic and eukaryotic cells, including cellular membranes and organelles.

CLO2: **Describe and analyse** the organization and roles of cytoskeletal elements and their involvement in cell motility, intracellular transport, and cell division.

CLO3: **Interpret** the mechanisms of cell cycle regulation, mitosis, and meiosis, and evaluate their significance in plant growth, development, and differentiation.

CLO4: **Elucidate** the structure, properties, and organization of nucleic acids, including chromatin architecture, DNA replication, and repair mechanisms.

CLO5: **Examine** the processes of transcription and post-transcriptional modifications, and assess the regulatory mechanisms controlling gene expression in eukaryotes.

CLO6: **Illustrate and evaluate** the process of translation and its regulation, linking gene expression to protein synthesis and cellular function

| Unit | Course Content | Learning Pedagogies* | CO(s) |
|---|---|---|---|
| I | **Cell Structure and Organization**<br>● Overview of prokaryotic and eukaryotic cells.<br>● Overview of Plant Cell Organization: Plant cells vs animal cells, Ultrastructure of plant cell, Cell theory and modern perspectives<br>● Plant Cell Wall: Structure and composition: primary and secondary cell wall, Cell wall components: cellulose, hemicellulose, pectin, lignin, Cell wall biosynthesis and assembly, Plasmodesmata<br>● Plasma membrane: structure, models (fluid mosaic); Membrane transport: Passive transport (diffusion, facilitated diffusion), Active transport and ion pumps, Vesicular transport (endocytosis, exocytosis).<br>● Ultrastructure and functions of cell organelles: Nucleus and nucleolus, Mitochondria (biogenesis and semi-autonomy), Chloroplast (structure and genome organization), Endoplasmic | Classroom Lecture, Seminars, Case-Based Learning, Research-Oriented Learning,<br>ICT-Enabled Learning, Self-Directed Learning | 01,02 |

| | | | |
|---|---|---|---|
| | reticulum and Golgi apparatus, Lysosomes, peroxisomes, vacuoles, Ribosomes, and Glyoxysomes.<br>● Role of plant endomembrane system in transport of biomolecules. | | |
| II | **Cell Function and Regulations**<br>● The cytoskeleton and cell motility – Structure, organization and functions of Microtubules, microfilaments and intermediate filaments; Role in: Cell shape determination, Intracellular transport, Organelle movement, Cell plate formation.<br>● Cell-Cell Interaction and Signalling in Plants: Plasmodesmata-mediated communication, Signal transduction pathways in plant cells, Role of calcium signalling and secondary messengers, Hormonal regulation at cellular level (auxin transport and signalling overview)<br>● Cell cycle and cell division: Stages of Mitosis and meiosis, Cell plate formation, Phragmoplast and preprophase band.<br>● Cell cycle regulation: cell cycle check points and their control; significance of cell cycle control in growth and differentiation in plants. Aging and Senescence. | Classroom Lecture, Seminars, Case-Based Learning, f, Research-Oriented Learning,<br>ICT-Enabled Learning, Self-Directed Learning | 03 |
| III | **Molecular Biology – Gene Structure**<br>● Nucleic acids as carriers of genetic information: Physical properties and structure of DNA and RNA.<br>● Denaturation (Tm value) and renaturation of DNA (CoT analysis).<br>● Organization of nucleic acids: nucleosome and chromatin structure and chromatin remodelling.<br>● Replication of DNA: Enzymes and proteins involved in replication and control of DNA replication.<br>● DNA repair mechanisms. | Classroom Lecture, Seminars, Experiential Learning, Research-Oriented Learning, ICT-Enabled Learning, Self-Directed Learning | 04 |
| IV | **Molecular Biology – Eukaryotic gene Expression and Regulation**<br>● Transcription of DNA: Promoters and types of RNA polymerases, Initiation of transcription; elongation and termination.<br>● Post transcriptional modifications of RNA: chemical modifications; mRNA splicing and mRNA modifications.<br>● Control of transcription in eukaryotes.<br>● Translation of RNA: structure of tRNA and rRNA; Stages of translation.<br>● Control of translation in eukaryotes. | Classroom Lecture, Seminars, Case-Based Learning, Experiential Learning, Research-Oriented Learning, ICT-Enabled Learning, Self-Directed Learning | 5,6 |

## Master of Science in BOTANY (Semester-I)

- **Assessment Methodologies**

**(C) 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)**

**(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 | 5 | 5 | 2 | 12 |
| II | 3 | 30 | 4 | 4 | 4 | 12 |
| III | 4 | 30 | 3 | 4 | 5 | 12 |
| IV | 5,6 | 30 | 2 | 4 | 8 | 14 |
| | | 120 | 14 | 17 | 19 | 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 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CLO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CLO3 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| CLO4 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 1 |
| CLO5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 1 |
| CLO6 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 1 |

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## Master of Science in BOTANY (Semester-I)

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<br>Project Evaluation<br>(Report, Presentation, Viva) | 50 |

- **Suggested Learning Materials Books:**

| Sr. No. | Title | Author(s) | Edition/ Year | Publisher |
|---|---|---|---|---|
| 1 | The Cell: A Molecular Approach. | Cooper, G., M., Hausman, R. E., | 7thEdn. (2015) | Sinauer Associates Inc, United States |
| 2 | Cell Biology. | Carp, G., | 7thEdn. (2013) | Wiley, United States |
| 3 | Molecular Biology of the Cell. | Albert, B., Johnson, A., Lewis, J., Raff, M., Robert, K., Walter, P., | 6thEdn. (2014) | Garland Science, United States |
| 4 | Molecular Cell Biology. | Lodish, H., Berk, A., Kaiser, C., A., | 6thEdn. (2007) | W. H. Freeman & Co Ltd, South Asia |
| 5 | Lewin's Genes X. | Krebs, J. E., | 10thEdn. (2009) | Jones & Bartlett Learning Publications, United States |

- **Online Resources (Open Source)**

| Sr.No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | **Introduction to Cell Biology** | **https://onlinecourses.nptel.ac.in/noc22_bt33/preview** |
| 2 | **Cell Biology, IIT Guwahati** | **https://nptel.ac.in/courses/102103012** |
| 3 | **Molecular Biology, IIT Guwahati** | **https://nptel.ac.in/courses/102103341** |
| 4 | **Molecular Biology** | **https://onlinecourses.nptel.ac.in/noc24_bt07/preview** |

## Master of Science in BOTANY (Semester-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSC | P2S01NCBOT04 | Lab I: Plant diversity and field botany | 0-8-0 | **120** | 04 |

- **Course Learning Outcomes (CLOs):**

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

**CLO1:** Identify and classify major groups of plants (algae, bryophytes, pteridophytes, gymnosperms, and angiosperms) based on morphological and anatomical characteristics.

**CLO2:** Examine and interpret vegetative and reproductive structures using microscopic and macroscopic techniques.

**CLO3:** Compare structural and reproductive diversity across plant groups to understand evolutionary relationships.

**CLO4:** Demonstrate skills in specimen collection, preservation, herbarium preparation, and field documentation.

**CLO5:** Analyze plant specimens and experimental observations to draw scientific conclusions.

**CLO6:** Communicate scientific findings effectively through practical records, diagrams, and viva voce.

| Unit | Course Content | Learning Pedagogies * | CLO(s) |
|---|---|---|---|
| | 1. Thallus organization of freshwater, marine and terrestrial algae<br>2. Reproductive structure of freshwater, marine and terrestrial algae<br>3. Observation of different species of algae from the fixed samples<br>4. Identification and observation of Algae and their diversity in the nearby water body<br>5. Collection and identification of bryophytic plants<br>6. Dissect out the different species of bryophytes.<br>7. Observation of different species of bryophyte from the fixed samples<br>8. Observation of reproductive structures of bryophytes from permanent slides | Interactive lectures<br>Experiential learning<br>Problem Based Learning | 1 to 5 |

## Master of Science in BOTANY (Semester-I)

| | | | |
|---|---|---|---|
| | 9. Observation of anatomical structure of bryophytes from permanent slides<br>10. Observation of different species of pteridophyte from the fixed samples<br>11. Observation of reproductive structures of pteridophytes from permanent slides<br>12. Observation of anatomical structure of pteridophytes from permanent slides<br>13. Comparative study of anatomy of vegetative and reproductive parts of Cycas, Ginkgo, Cedrus, Abnies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Podocarpus, Agathis, Taxus, Ephedra and Gnetum.<br>14. Study of important fossil gymnosperms and angiosperms from permanent slides/ specimens/photos.<br>15. Morphological description of different angiosperms to record the diversity among those plants. (This will cover the locally available plant families through repeated lab exercises).<br>16. Comparative study of floral morphology and diversity of various groups of angiosperms to understand the evolutionary progress among them.<br>17. Field trips within and around the campus to be conducted for compilation of field notes and preparation of herbarium sheets of a few local plants, wild or cultivated. | Collaborative Learning | |

- **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 marks
**(d) Group Learning:** 05 marks
**(e) Spotting/Quiz:** 05 marks
**(f) Viva Voce:** 05 marks

**b. Internal Summative Assessment**

**Problem based learning:** 20 marks

**(B) External Assessment:** 50 marks

**(B) Weightage of Learning Efforts for External Assessment**

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

## Master of Science in BOTANY (Semester-I)

- **CLOs – PLOs Matrix**

| CLO / PLO | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLO1** | **3** | **2** | **-** | **1** | **-** | **1** | **2** | **1** | **2** | **1** | **-** | **-** |
| **CLO2** | **2** | **3** | **-** | **1** | **1** | **-** | **2** | **2** | **1** | **-** | **-** | **1** |
| **CLO3** | **3** | **1** | **-** | **1** | **1** | **1** | **3** | **1** | **1** | **1** | **-** | **1** |
| **CLO4** | **2** | **3** | **2** | **1** | **1** | **2** | **1** | **2** | **2** | **1** | **1** | **1** |
| **CLO5** | **2** | **2** | **-** | **1** | **1** | **1** | **3** | **3** | **2** | **1** | **-** | **1** |
| **CLO6** | **2** | **1** | **1** | **1** | **1** | **-** | **1** | **1** | **3** | **-** | **1** | **-** |

Values to the 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% |

## Master of Science in BOTANY (Semester-I)

- **Suggested Learning Materials Books:**

| Sr.No. | Title | Author(s) | Edition/Year | Publisher |
|---|---|---|---|---|
| 1 | Round, F. E. | The Biology of Algae | | Cambridge University Press, Cambridge |
| 2 | Sporne, K. K. | The Morphology of Pteridophytes. | | B. I. Publishing Pvt. Ltd., Bombay. |
| 3 | Puri, P. | Bryophytes | | Atma Ram & Sons, Delhi. |
| 4 | Coulter and Chamberlein J. M. | Morphology of Gymnosperms. | 1978 | Cambridge university press London and edinburgh |
| 5 | Eames A J | Morphology of Angiosperms | 1961 | McGraw Hill Book Co. |
| 6 | Foster A. S. and Gifford E. M. | Comparative Morphology of Vascular Plants. | 1959 | W. H. Freeman and Company, San Francisco |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | **Plant Biology – Open Learn (Open University):** | **https://www.open.edu/openlearncreate/course/view.php?id=8278** |
| 2 | **Field Botany (Certificate) < North Carolina State University** | **https://catalog.ncsu.edu/undergraduate/agriculture-life-sciences/plant- microbial-biology/field-botany- certificate/** |
| 3 | **Vascular Plant Herbarium** | **https://herbarium.ncsu.edu/certificate.h tm** |

## Master of Science in BOTANY (Semester-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSC | P2S01NCBOT05 | Cell Biology and Biomolecular Techniques | 0-8-0 | **120** | 04 |

**Course Learning Outcomes (CLOs):**
On completion of this course, students will be able to:

**CLO1:** Demonstrate knowledge of laboratory safety, reagent preparation, and basic biochemical calculations.

**CLO2:** Apply spectrophotometric and chromatographic techniques for analysis of biomolecules.

**CLO3:** Perform separation and quantification of nucleic acids and proteins using electrophoresis and biochemical assays.

**CLO4:** Examine cellular structures and organelles using microscopy and staining techniques.
**CLO5:** Analyze experimental data and validate scientific principles such as Beer-Lambert law.
**CLO6:** Communicate experimental findings through scientific records, diagrams, and viva voce.

| Unit | Course Content | Learning Pedagogies * | CLO (s) |
|---|---|---|---|
| | 1. Orientation to the Botany laboratory, general laboratory safety and good laboratory practices.<br>2. Biochemical calculations and Preparation of reagents.<br>3. Study of microscopic techniques: bright field, phase contrast, fluorescence (demonstration).<br>4. Determination of λmax and validation of Beer-Lamberts law.<br>5. Quantification of nucleic acids by UV spectrophotometry and its separation by agarose gel electrophoresis<br>6. Estimation of DNA by DPA/orcinol method<br>7. Estimation of RNA<br>8. Gel electrophoresis of protein.<br>9. Estimation of protein by Folins Lowry Method<br>10. Separation of amino acids by thin layer chromatography and HPTLC.<br>11. Purification of analytes by Flash Chromatography<br>12. UV-Visible spectral analysis of plant metabolites.<br>13. Separation of proteins by native and SDS PAGE<br>14. Observation of various cell organelles (Nucleus, mitochondria, chloroplast etc.) by staining with appropriate stains. | Interactive lectures<br><br>Experiential learning<br><br>Problem Based Learning<br><br>Collaborative Learning | 1 to 5 |

| | | | |
|---|---|---|---|
| | 15. Observation of cytoskeleton in onion epidermal cells / cheek cells using stains.<br>16. Observation of starch, protein and lipid molecules in cell.<br>17. Observation of cellular arrangement in Plant organs<br>18. Meiosis and Mitosis in plant cells. | | |

- **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 marks
**(j) Group Learning:** 05 marks
**(k) Spotting/Quiz:** 05 marks
**(l) Viva Voce:** 05 marks

**d. Internal Summative Assessment**

**Problem based learning:** 20 marks

**(D) External Assessment: 50 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) | |
| | 1 to 5 | 120 | 10 | 10 | 30 | 50 |

- **CLOs – PLOs Matrix**

| CLO / PLO | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO1 | 2 | 3 | 2 | 1 | - | - | 1 | - | 1 | - | - | - |
| CLO2 | 2 | 3 | - | 1 | 2 | - | 2 | 2 | 1 | - | - | 1 |
| CLO3 | 2 | 3 | - | 1 | 2 | - | 2 | 3 | 1 | - | - | 1 |
| CLO4 | 2 | 3 | - | 1 | 1 | - | 3 | - | 1 | - | - | - |
| CLO5 | 1 | 2 | - | 1 | 1 | - | 3 | 3 | 1 | - | - | 1 |
| CLO6 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 3 | - | 1 | - |

Values to the 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 | - |

## Master of Science in BOTANY (Semester-I)

- **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 | Standard Methods of Biochemical | Thimmaiah S. K. | (2012) | Kalyani Publishes, New Delhi, India |
| 2 | An introduction to practical Biochemistry | David T. Plummer | | McGraw Hill book company |
| 3 | Biochemical Methods | S. Sadasivam and A. Manickam | 2nd | New Age Internation al (P) Limited, Publishers , India |
| 4 | Principles and Techniques of Biochemistry and Molecular Biology | Keith Wilson & John Walker | 8th (2018) | Cambridg e University Press |
| 5 | Biophysical Chemistry (Part II: Techniques for the Study of Biological Structure and Function) | Charles R. Cantor & Paul R. Schimmel | 1980 (reprint) | W.H. Freeman |
| 6 | Practical Biochemistry: Principles and Techniques | Keith Wilson & John Walker | 7th (2010) | Cambridg e University Press |
| 7 | Protein Purification: Principles and Practice | Robert K. Scopes | 3rd (1994) | Springer |
| 8 | Gel Electrophoresis of Proteins and Nucleic Acids | R. Westermeier | 4th (2016) | Valter de Gruyter |
| 9 | Introduction to Spectroscopy | Donald L. Pavia | 5th (2015) | Cengage Learning |
| 10 | Laboratory Safety for Chemistry Students | Robert H. Hill & David C. Finster | 2nd (2016) | Wiley |

## Master of Science in BOTANY (Semester-I)

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | **JoVE (Journal of Visualized Experiments)** | **jove.com** |
| 2 | **LabXchange** | **labxchange.org** |
| 3 | **Biochemistry Free & Easy** | **biochem.science.oregonstate.edu** |
| 4 | **NIH Principles of Chromatography** | **chromatography.nih.gov** |

## Master of Science in BOTANY (Semester-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSE | P2S01NEBOT01 | Biosafety and Bioethics | 2-0-0 | 60 | 02 |

**Course Learning Outcomes (CLOs)**

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

**CLO1** Analyze biosafety levels (BSL 1–4) and containment strategies to determine appropriate protocols for handling novel or high-risk biological agents, including radioisotope use.

**CLO2** Evaluate the adequacy of India's regulatory framework and international agreements in managing risks associated with environmental release or commercial approval of GMOs/LMOs.

**CLO3** Create an ethical decision-making framework that integrates core bioethics principles to resolve a complex dilemma involving human or animal research, referencing ICMR, CPCSEA, and CECHR guidelines.

**CLO4** Critique real-world cases of biopiracy (e.g., neem, turmeric, basmati) and biodiversity loss, proposing alternative ethical and policy-based solutions that balance conservation, indigenous rights, and development.

**CLO5** Synthesize principles of biosafety, GMO regulation, and bioethics to formulate a justified position on an emerging issue.

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | **Biosafety**<br><br>Principles of Biosafety.<br>Biohazard and Biosecurity: Concepts and components. WHO Risk Group Classification of Microorganisms<br>Biocontainment: good laboratory practices and techniques, safety equipment, types of containment (physical and biological).<br>AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions to be taken.<br>Biosafety levels (BSL 1, 2, 3, 4), barriers (physical and secondary).<br>Management of biohazardous waste.<br>WTO and other international agreements related to biosafety. | Classroom Lecture (CL); Seminars; Collaborative Learning; Group Learning; ICT enabled learning | **1** |

## Master of Science in BOTANY (Semester-I)

| | | | |
|---|---|---|---|
| **II** | **Genetically modified organism: concerns and challenges**<br>GMOs/LMOs: Government of India definition of genetically modified organisms (GMOs) and living modified organisms (LMOs), GRAS microorganisms.<br>Biosafety guidelines and regulations: Biosafety guidelines of India. Constitution and Role of Institutional Biosafety Committees (IBSC)). Review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMO in India<br>Risk Analysis, and Assessment for Environmental release of GMOs, Cartagena Protocol. Biosafety assessment procedures for biotech foods and related products, case studies of relevant Indian GMOs (Bt cotton, Bt Brinjal). Biosafety assessment of pharmaceutical products such as drugs/vaccines etc | Classroom Lecture (CL);<br>Seminars;<br>Collaborative Learning;<br>ICT - Enabled Learning | **2** |
| **III** | **Principles and Practices**<br>Role of ethics committees and Institutional Review Boards<br>National Ethical Guidelines (ICMR Guidelines)<br>Research Ethics: Committee for Control and Supervision of Experiments on Animals (CCSEA) guidelines for conducting animal experiments in India; Central Ethics Committee on Human Research (CECHR) guidelines.<br>Environmental and Global Bioethics: Biodiversity conservation ethics and Biopiracy issues.<br>Emerging ethical issues: AI and big data ethics in Biology and Health care | Classroom Lecture (CL);<br>Seminars;<br>Collaborative Learning;<br>Case-based learning (CBL). | **3,4,5** |

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**

- **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** | 18 | - | 01 | 07 | 08 |
| **II** | **2,5** | 20 | 01 | 01 | 07 | 09 |
| **III** | **3,4,5** | 22 | 01 | 01 | 06 | 08 |
| | | **60** | **02** | **03** | **20** | **25** |

## Master of Science in BOTANY (Semester-I)

- **CLOs – PLOs Matrix**

| CLOs \ PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO 1: | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 1 |
| CLO 2: | 3 | 1 | 3 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 2 | 1 |
| CLO 3: | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 2 |
| CLO 4: | 3 | 1 | 3 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 2 | 2 |
| CLO 5: | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 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 | 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/ | Publisher |
|---|---|---|---|---|
| 1 | AN INTRODUCTION TO ETHICAL, SAFETY & IPR ISSUES IN BIOTECNOLOGY | PADMA NAMBISAN | 1, 2017 | ACADEMIC PRESS |
| 2 | BIOETHICS AND BIOSAFETY | M.K. SATEESH | 1, 2014 | I.K.INTERNATIONAL PUBLISHING HOUDE PVT. LTD.NEW DELHI |
| 3 | BIOETHICS AND BIOSAFETY IN BIOTECHNOLOGY | V. SREE KRISHNA | 1,2007 | NEW AGE INTERNATIONAL LTD., NEW DELHI |
| 4 | BIOSAFETY IN INDUSTRIAL BIOTECHNOLOGY | P. HAMEBLETON MELLING | 1, 1994 | BLACKIE ACADEMIC & PROFESSIONAL, BISHOPBRODGE, GLASGOW, UK |

- **Online Resources (Open Source)**

| Sr.No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | Ethics Review of Human Research | https://onlinecourses.swayam2.ac.in/e-learning/preview/aic20_ge08 |

## Master of Science in BOTANY (Semester-I)

| | | |
|---|---|---|
| 2 | Committee for control and supervision of experiments on animals | https://ccsea.gov.in/Auth/index.aspx |
| 3 | Central Ethics Committee on Human Research | https://ethics.ncdirindia.org/CECHR_Details.aspx |
| 4 | Indian Biosafety Knowledge Portal | https://ibkp.dbt.gov.in/ |

# 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-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSE | P2S01NEBOT02 | Entrepreneurship Fundamentals | 2-0-0 | 60 | 02 |

This course has been designed in consultation with Wadhwani Foundation and will be offered using LMS in collaboration with Wadhwani Foundation.

**Course Learning Outcomes (CLOs)**

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

| | |
|---|---|
| **CLO1** | Develop an entrepreneurial mindset and appreciate the concepts of entrepreneurship, cultivate essential attributes to become an entrepreneur or Intrapreneur and demonstrate skills such as problem solving, team building, creativity and leadership |
| **CLO2** | Comprehend the process of problem-opportunity identification through design thinking, identify market potential and customers while developing a compelling value proposition solution |
| **CLO3** | Analyse and refine business models to ensure sustainability and profitability |
| **CLO4** | Build Prototype for Proof of Concept and validate MVP of their practice venture idea |
| **CLO5** | Create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture |
| **CLO6** | Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders |

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | **Entrepreneurship Fundamentals & Context**<br>Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skillsets, attributes and networks while on campus. | Interactive Classroom Lecture, Venture Activity, ICT enabled | **1** |
| II | **Problem & Customer Identification**<br>Understanding and analysing the macro-Problem and Industry perspective, technological, socio economic and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problem using Design thinking principles. Analysing problem and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping and assessing initial opportunity. | Interactive Classroom Lecture, Collaborative learning, Experiential Learning | **1,2** |

## Master of Science in BOTANY (Semester-I)

| | | | |
|---|---|---|---|
| **III** | **Solution design & Prototyping**<br><br>Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition. Developing Problem-solution fit in an iterative manner. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating value, features and benefits. Initial testing for proof-of-concept and iterate on the prototype. | Collaborative Learning,<br><br>ICT enabled | **1,2,3,4** |
| **IV** | **Opportunity Assessment and Sizing**<br>Assess relative market position via competition analysis, sizing the market and assess scope and potential scale of the opportunity | Interactive Classroom Lecture, Venture Activity | **1,3** |
| **V** | **Business & Financial Model, Go-to-Market Plan**<br>Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach.<br>Business planning: components of Business plan- Sales plan, People plan and financial plan.<br>Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance.<br>Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy.<br>Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options. | Interactive Classroom Lecture,<br><br>Group discussion,<br><br>Collaborative learning | **1,5** |
| **VI** | **Scale Outlook and Venture Pitch readiness**<br>Understand and identify potential and aspiration for scale vis a vis your venture idea.<br>Persuasive Storytelling and its key components. Build an Investor ready pitch deck. | Expert Talks, Group discussion, Collaborative learning | **6** |

- **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**

# 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-I)

**(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** | 09 | 1 | 1 | 03 | 04 |
| **II** | **1,2** | 09 | - | 1 | 03 | 04 |
| **III** | **1,2,3,4** | 10 | 1 | - | 03 | 04 |
| **IV** | **1,3** | 10 | - | - | 03 | 04 |
| **V** | **1,5** | 11 | - | - | 04 | 05 |
| **VI** | **6** | 11 | - | - | 05 | 04 |
| | | **60** | **02** | **02** | **21** | **25** |

- **CLOs – PLOs Matrix**

| CLOs \ PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1:** | – | – | 2 | 2 | 2 | 1 | 3 | – | 2 | 2 | 3 | 3 |
| **CLO 2:** | – | – | – | 2 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 3 |
| **CLO 3:** | – | – | 1 | 2 | 3 | 2 | 3 | 1 | 1 | 3 | 2 | 3 |
| **CLO 4:** | – | 1 | 1 | 2 | 3 | 2 | 3 | 3 | 1 | 2 | 2 | 3 |
| **CLO 5:** | – | – | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CLO 6:** | – | – | 2 | 2 | 2 | 1 | 2 | – | 3 | 2 | 3 | 3 |

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 |

# 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-I)

- **Suggested Learning Materials Books:**

| Sr. No. | Title | Author(s) | Edition/Year | Publisher |
|---|---|---|---|---|
| 1 | Entrepreneurship | Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha | 11, 2020 | McGrawHill |
| 2 | The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. | Ries E. | 2011 | Crown Business |
| 3 | Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. | Osterwalder, A., & Pigneur, Y. | 2010 | John Wiley & Sons |
| 4 | Start with Why | Simon Sinek | 2011 | Penguin Books limited |
| 5 | Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation | Brown Tim | 2019 | Harper Business |
| 6 | The Dolphin and the Shark: Stories on Entrepreneurship | Namita Thapar | 2022 | Penguin Books Limited |
| 7 | Effectuation: Elements of Entrepreneurial Expertise, | Saras D. Sarasvathy | 2008 | Elgar Publishing Ltd |

- **Online Resources (Open Source)**

| Sr.No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | NPTEL – Entrepreneurship Essentials | https://nptel.ac.in/courses/110105145 |
| 2 | Startup India Learning Program (Free certification modules) | https://www.startupindia.gov.in/content/sih/en/learning.html |
| 3 | NSDC – Entrepreneurship Skill Development Resources | https://nsdcindia.org/foundation-courses |

## Master of Science in BOTANY (Semester-I)

| | | |
|---|---|---|
| 4 | Y Combinator – Startup Library (Free videos & guides) | https://www.ycombinator.com/library |
| 5 | Business Model Canvas (Strategyzer) – Interactive tool | https://www.strategyzer.com/canvas/business-model-canvas |
| 6 | Design Thinking for Social Innovation (IDEO U – Free resources) | https://www.ideou.com/blogs/inspiration/design-thinking-for-social-innovation |

# 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-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSE | P2S01NEBOT03 | Mathematics Essential for Biologists | 2-0-0 | **60** | 02 |

**Course Learning Outcomes (CLOs)**

After successful completion of the course, students will be able to:

**CLO1:** Demonstrate conceptual understanding of number systems, logarithmic, and exponential functions for application in scientific contexts.

**CLO2:** Apply appropriate mathematical functions and graphical techniques to analyse and interpret biological data.

**CLO3:** Employ trigonometric and complex number concepts to solve problems in scientific and biological domains.

**CLO4:** Analyse rates of change in biological systems using principles of differential calculus.

**CLO5:** Apply integral calculus to evaluate total change, area, and volume in relevant scientific applications.

**CLO6:** Utilise algebraic methods, including matrices and determinants, to solve systems of equations in biological contexts.

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | **Fundamental Mathematical Concepts for Scientific Analysis:** Number systems: Rational, Irrational, and Real numbers; Scientific notation and orders of magnitude; Logarithmic functions: Natural vs common logarithm; Exponential functions and their applications in science; Properties of logarithmic and exponential functions; Functions in biology: Types and graphical representation; Dependent and independent variables in biochemical analysis | Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning | 1,2 |
| II | **Mathematical Tools and Representations in Biology:** Trigonometric functions and identities; Complex numbers: Imaginary numbers and Argand plane representation; Algebra of complex numbers and scientific applications; Slope of functions and their interpretation; Introduction to calculus through geometric concepts | Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning | 2, 4 |

## Master of Science in BOTANY (Semester-I)

| | | | |
|---|---|---|---|
| III | **Calculus and Algebraic Techniques in Biological Systems:** Limits and continuity (from first principles), Differential calculus: First and second derivatives; Applications in biology: Growth rate analysis, Spectroscopy (peak/trough identification), Curvature analysis, Integral calculus: Indefinite and definite integrals, Applications of integration: Area, volume, and total change, Simultaneous equations (two and three variables), Introduction to matrices and determinants | Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning | 2,4 |

- **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 Cos | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) | | | Total Marks |
|---|---|---|---|---|---|---|
| | | | Remember (R) | Understanding (U) | Application/ Analyse & above (A) | |
| **I** | **1,2** | **20** | **0** | 1 | **07** | **08** |
| **II** | **2,4** | **20** | 1 | 1 | **07** | **09** |
| **III** | **2,4** | **20** | 1 | 1 | **06** | **08** |
| | | **60** | **02** | **03** | **20** | **25** |

**CLO-PLO Matrix:**

| CLO \ PLO | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO1 | 2 | - | - | 1 | 2 | - | 2 | 1 | 1 | - | - | 1 |
| CLO2 | 1 | 2 | - | 1 | 3 | 1 | 3 | 3 | 2 | - | - | 1 |
| CLO3 | 1 | - | - | 1 | 2 | - | 2 | 1 | 1 | - | - | 1 |
| CLO4 | 1 | 1 | - | 1 | 3 | 1 | 3 | 3 | 1 | - | - | 1 |
| CLO5 | 1 | 1 | - | 1 | 3 | 1 | 3 | 3 | 1 | - | - | 1 |
| CLO6 | 1 | 1 | - | 1 | 3 | 1 | 3 | 3 | 1 | - | - | 1 |

## Master of Science in BOTANY (Semester-I)

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, | 60% |
| 2 | End-Semester Examination | Written Exam/Practical Exam<br>Project Evaluation<br>(Report, Presentation, Viva) | 40% |

- **Suggested Learning Materials Books:**

| Sr.No. | Title | Author(s) | Edition/Year | Publisher |
|---|---|---|---|---|
| 1 | Introduction to Mathematics for Life Scientists | E. Batschelet | 2nd ed. 2008 | SPRINGER. |
| 2 | Textbooks of Mathematics for classes XI and XII. | | 3rd ed. (2003) | NCERT, NEW DELHI |
| 3 | Mathematics for the Life Science | Glenn Ledder | 2013 | SPRINGER |
| 4 | Handbook of Mathematics for Biosciences and Paramedical Students | PUNDIR, S. K. | 2016 | CBS PUBLISHER AND DISTRIBUTORS |
| 5 | Basic Mathematics for the Biological and Social Sciences | (F.H.C.Marriott): | 1970 | ELSEVIER |

- **Online Resources (Open Source)**

| Sr. No | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | Fundamental Mathematical Concepts for Scientific Analysis | https://egyankosh.ac.in/bitstream/123456789/46811/1/Unit-10.pdf |
| 2 | Fundamental Mathematical Concepts for Scientific Analysis | https://onlinecourses.nptel.ac.in/noc20_bt13/preview |
| 3 | Biocalculus | https://uotechnology.edu.iq/dep/bme/english/Pages/Lectures/mathmatix/2stage |
| 4 | Trigonometry | https://www.khanacademy.org/math/trigonometry |
| 5 | Algebra | https://www.khanacademy.org/math/algebra |

# 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-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSE | P2S01NEBOT04 | Principles of Ecology | 2-0-0 | 60 | 02 |

**Course Learning Outcomes (CLOs)**

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

**CLO1** Analyse population dynamics by applying mathematical models (exponential, logistic, and r/K selection) and constructing life tables to predict population viability and extinction risks in metapopulations.

**CLO2** Evaluate the concepts of habitat and ecological niche to interpret community structure, species diversity patterns, and the mechanisms that maintain ecosystem stability.

**CLO3** Critically analyse the evolutionary and ecological consequences of species interactions-including competition, predation, and various forms of symbiosis-on community organization.

**CLO4** Quantify energy transfer efficiency across trophic levels and model the flux of matter through major biogeochemical cycles (C, N, P) across diverse terrestrial and aquatic ecosystems.

**CLO5** Synthesize the processes of primary and secondary succession to predict how ecosystems recover from natural and anthropogenic disturbances, including the role of keystone species.

**CLO6** Assess the impact of global change drivers (climate change, land-use change, and invasive species) on ecosystem services and formulate evidence-based strategies for sustainable management.

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | **Fundamentals of Ecology and Population Ecology** Introduction to Ecology: Levels of organization: individual, population, community, ecosystem, biosphere; Abiotic and biotic factors, Ecological adaptations; Population Ecology: Population attributes: density, natality, mortality, dispersal, Population distribution and age structure, Sex ratio and life history strategies (r and K selection); Population Growth and Regulation: Exponential and logistic growth models, Carrying capacity and biotic potential, Density-dependent and density-independent factors, Population regulation mechanisms; Advanced Population Concepts: Life tables and survivorship curves, Metapopulations: habitat fragmentation, connectivity, extinction risk | Classroom Lecture (CL) Problem- Based Learning (PBL) Seminars (Student-led) Micro- Projects Collaborative Learning, ICT - Enabled Learning | 1 |

## Master of Science in BOTANY (Semester-I)

| | | | |
|---|---|---|---|
| **II** | **Community Ecology and Species Interactions:** Community Organization: Concept of habitat and ecological niche, Community structure and organization, Species diversity and ecosystem stability; Species Interactions: Competition (intra- and interspecific), Predation and herbivory, Mutualism, commensalism, parasitism; Community Dynamics: Food chains and food webs, Trophic levels and ecological pyramids, Keystone and dominant species; Ecological Succession: Types: primary and secondary succession, Causes and processes, Community development and stability | Classroom Lecture (CL)<br>Problem-Based Learning (PBL)<br>Seminars (Student-led)<br>Micro-Projects<br>Collaborative Learning, ICT - Enabled Learning | 2,3, 5 |
| **III** | **Ecosystem Structure and Function**: Energy flow in ecosystems, Primary productivity and trophic efficiency, Ecosystem structure and functioning, Biogeochemical Cycles: Carbon cycle, Nitrogen cycle, Phosphorus cycle, Water cycle; Ecosystem Types: Forest, grassland, desert ecosystems, Aquatic ecosystems, Agro-ecosystems and plantations, Structure and functional features; Human Impacts on Ecosystems: Land use and land-cover change, Climate change and global warming, Pollution and invasive species, Ecosystem services and sustainability | Classroom Lecture (CL)<br>Problem-Based Learning (PBL)<br>Seminars (Student-led)<br>Micro-Projects<br>Collaborative Learning, Case-based learning (CBL) | 4,6 |

- **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**

## Master of Science in BOTANY (Semester-I)

- **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 | 18 | 0 | 1 | 7 | 8 |
| II | 2, 3, 5 | 20 | 1 | 1 | 7 | 9 |
| III | 4, 6 | 22 | 1 | 1 | 6 | 8 |
| | | 60 | 02 | 03 | 20 | 25 |

- **CLOs – PLOs Matrix**

| CLOs \ PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO 1: | 3 | - | - | - | 2 | - | 3 | 3 | - | - | - | - |
| CLO 2: | 3 | - | - | - | - | - | 2 | - | - | - | - | - |
| CLO 3: | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CLO 4: | 3 | - | - | - | 2 | - | 3 | 3 | - | - | - | - |
| CLO 5: | 3 | - | - | - | - | - | | - | - | 2 | - | - |
| CLO 6: | 3 | - | 1 | 2 | - | 3 | 3 | - | - | 3 | - | 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, Group Learning, Written Exam | 50 |
| 2 | End-Semester Examination | Written Exam | 50 |

## Master of Science in BOTANY (Semester-I)

- **Suggested Learning Materials Books:**

| Sr.No. | Title | Author(s) | Edition/Year | Publisher |
|---|---|---|---|---|
| 1 | Ecology | Begon, M. et al | 1996 | Blackwell Science, Cambridge, USA |
| 2 | Fundamentals of Ecology | Odum, E.P., Barrett, G., W. | 2005 | Thomson Brooks/Cole, Belmor, CA |
| 3 | Textbook of Plant Ecology | Ambasth, R.S., Ambasth, N.K. | 2017 | Students Friends Publishers, Varanasi |
| 4 | Ecology: Global Insights and Investigations | Peter D. Stiling | 2nd Edn 2015 | McGraw-Hill |
| 5 | A Textbook on Ecology and Environmental Science | Mahendran P., P., Rajan, P., M | 2008 | Agrotech Publishing Academy |
| 6 | Ecology and Environment | Sharma, P.D., | 2001 | Rastogi Publications |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | Fundamentals of Ecology | https://onlinecourses.nptel.ac.in/noc25_ge14/preview?utm |
| 2 | Wildlife Ecology | https://onlinecourses.nptel.ac.in/noc22_bt55/preview?utm |

# 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-I)

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSE | P2S01NEBOT05 | Pharmaceutical Microbiology | 2-0-0 | **60** | 02 |

**Course Learning Outcomes (CLOs)**

After successful completion of this course, students will be able to:

**CLO1:** Explain fundamental concepts of microbiology and classify microorganisms relevant to pharmaceutical sciences.
**CLO2:** Describe the mechanisms of action of antimicrobial agents and analyse the development of antibiotic resistance.
**CLO3:** Apply sterilization, disinfection, and aseptic techniques in pharmaceutical manufacturing.
**CLO4:** Evaluate microbial contamination, spoilage, and preservation strategies in pharmaceutical products.
**CLO5:** Interpret microbiological quality control tests and regulatory requirements in pharmaceutical industries.

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | **Fundamentals of Microbiology and Chemotherapeutic Agents:** History and significance of microbiology in pharmacy; Classification of microorganisms: bacteria, fungi, viruses; Microbial morphology: bacterial cell structure; Microbial growth: nutritional requirements, physical factors (pH, temperature, osmotic pressure), bacterial growth curve Introduction to chemotherapeutic agents: history and development; Types of antimicrobial agents: antibacterial, antifungal, antiviral, antiprotozoal, anticancer agents; Classification of antibiotics: synthetic, semisynthetic, natural.<br>Mechanism of action of antimicrobial agents (cell wall, protein synthesis, nucleic acid inhibition) | Classroom Lecture (CL)<br>Seminars Case-Based Learning (CBL), ICT-Enabled Learning, Collaborative Learning | CLO1,2 |
| II | **Control of Microorganisms and Antimicrobial Strategies:**<br>Focuses on microbial control, resistance, and emerging therapeutic approaches; Sterilisation principles in the pharmaceutical industries; Methods of sterilisation: Physical: moist heat (autoclaving), dry heat, radiation, filtration; Chemical: gaseous sterilisation (ethylene oxide), disinfectants; Validation of sterilisation: biological and chemical indicators; Disinfectant evaluation: phenol coefficient, Kelsey-Sykes test; Antibiotic resistance: development and mechanisms; New therapeutics: Antimicrobial peptides (history, properties, mode of action, applications), Phage therapy: introduction, lytic cycle, therapeutic applications; Plant-based antimicrobial agents | Classroom Lecture (CL)<br>Seminars Case-Based Learning (CBL), ICT-Enabled Learning, Collaborative Learning | CLO2,3 |

## Master of Science in BOTANY (Semester-I)

| | | | |
|---|---|---|---|
| III | **Pharmaceutical Microbiology in Industry and Quality Control:** Covers industrial applications, contamination control, and regulatory aspects; Microbial contamination and spoilage of pharmaceutical products: Sources, factors affecting growth, impact on formulations; Environmental monitoring and aseptic processing: Cleanroom classification (Grade A–D), HEPA filters; Sources of contamination (air, personnel, water – WFI), Monitoring methods (settle plates, air samplers, surface methods); Microbiological quality control tests: Sterility testing (membrane filtration, direct inoculation), Microbial limit tests (MLT), Endotoxin testing (LAL test); Preservatives in pharmaceutical products: Principles, ideal properties, evaluation and stability, Preservative efficacy testing (PET); Regulatory aspects: Pharmacopoeias: IP, BP, USP, Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP, cGMP) | Classroom Lecture (CL)<br>Seminars Case-Based Learning (CBL), ICT-Enabled Learning, Collaborative Learning,<br>Industrial visit | CLO3,4,5 |

- **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) External Assessment: 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** | 18 | 1 | 1 | 6 | 8 |
| II | **2, 3** | 20 | 1 | 1 | 6 | 8 |
| III | **3, 4, 5** | 22 | - | - | 9 | 9 |
| | | **60** | **02** | **02** | **21** | **25** |

**CLO-PLO Matrix:**

| CLO \ PLO | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| CLO1 | 3 | 1 | - | 1 | 2 | - | 1 | - | - | - | - | - |
| CLO2 | 2 | 1 | - | 1 | 2 | 2 | 3 | 1 | - | - | - | - |
| CLO3 | 1 | 3 | 2 | - | 2 | - | 2 | 3 | 1 | - | 1 | - |
| CLO4 | 2 | 2 | 1 | - | 2 | 3 | 2 | 2 | - | 2 | 1 | - |
| CLO5 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 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<br>Project Evaluation<br>(Report, Presentation, Viva) | 50 |

- **Suggested Learning Materials Books:**

| Sr. No. | Title | Author(s) | Edition/Year | Publisher |
|---|---|---|---|---|
| 1 | Hugo and Russell's *Pharmaceutical Microbiology* | Ed. Brendan F. Gilmore and Ste phen P. Denyer | 9th ed. 2023 | Wiley Blackwell |
| 2 | Pelczar, Chan, and Krieg *Microbiology* – For fundamental microbial biology | NOEL R. KRIEG MICHALE J. PELCZAR JR, | 5th ed 2023 | Affiliated East West Press Pvt. Ltd. |
| 3 | Pharmaceutical Microbiology | **Error! Hyperli nk** | 18th ed. 2023 | Nirali Prakashan |

| | | | | |
|---|---|---|---|---|
| **4** | Error! Hyperlink reference not valid. - | Error! Hyperlink reference not valid. | 2015 | Woodhead Publishing |
| **5** | Error! Hyperlink reference not valid. Error! Hyperlink reference not valid. | Error! Hyperlink reference not valid. | 2011 | I K International Publishing House Pvt. Ltd |

- **Online Resources (Open Source)**

| **Sr. No.** | **Description of Resource(s)** | **Weblink** |
|---|---|---|
| 1 | Natural antimicrobials from plants: Recent advances and future | **https://doi.org/10.1016/j.foodchem.2023.137231** |
| 2 | Advancements in plant-based antimicrobial therapies | **https://doi.org/10.51470/MA.2023.5.1.19** |
| 3 | Determination of the toxicity of a test chemical to the drug | **https://www.oecd.org/en/publications/guidance** |