MURSHIDABAD MAHARAJA KRISHNANATH UNIVERSITY, BERHAMPORE

DEPARTMENT OF BOTANY

SYLLABUS FOR 1ST SEMESTER BOTANY

POST GRADUATE (PG) PROGRAM FRAMED ACCORDING TO NATIONAL EDUCATION POLICY (NEP 2020)

2026

BERHAMPORE, MURSHIDABAD

MURSHIDABAD MAHARAJA KRISHNANATH UNIVERSITY, BERHAMPORE

Master of Science (M. Sc.) Syllabus in Botany, 2026

Orientation of Courses in First Semesters for M.Sc. in Botany

Course Code	Course Title	Marks	Credits
PG-BOT-CC-T-101	Microbiology and Immunology (Theory)	**60**	**3**
PG-BOT-CC-P-102	Microbiology and Immunology (Practical)	**20**	**1**
PG-BOT-CC-T-103	Phycology and Bryology (Theory)	**60**	**3**
PG-BOT-CC-P-104	Phycology and Bryology (Practical)	**20**	**1**
PG-BOT-CC-T-105	Pteridophytes and Gymnosperms (Theory)	**60**	**3**
PG-BOT-CC-P-106	Pteridophytes and Gymnosperms (Practical)	**20**	**1**
PG-BOT-CC-T-107	Indigenous Knowledge of Plants (Theory)	**60**	**3**
PG-BOT-CC-P-108	Indigenous Knowledge of Plants (Practical)	**20**	**1**
PG-BOT-IDC-T-101	Fundamentals of Plant Science(Theory)	**80**	**4**
Total		**400**	**20**

1 Credit = 20 Marks.
For Each Core Course,
Theory= 60 Marks (20+40)
Internal Assessment = 20 (15 internal assessment + 5 class attendance)
End Semester = 40
&
Practical= 20 Marks

1st Semester

PG-BOT-CC-T-101: Microbiology and Immunology

Theory (60 marks; 3 credits, 60 Lecture hours)

Course Objectives:

This course aims to increase the understanding of the students about the diversity of microorganisms, their classification, structure, growth, pathogenicity, their role in environment and also the immune system of cells & organs.

Course Learning Outcomes:

After completion of the course the learners will be able to:

- Understand about the diversity of microorganisms, their classification, growth, genetic analysis and pathogenicity.
- Explain their role in environment.
- Develop theoretical and technical skills of basic microbiology (sterilize, isolate, culture, preserve microbes).

Microbiology:

1. Taxonomy and Phylogeny: Classification of Bacteria (according to Bergey's Manual); Salient features of major bacterial groups. [2]
2. Nutrition and Growth: Types of culture media, Isolation of pure culture, Enrichment culture techniques, Maintenance and preservation of Bacterial cultures, Growth kinetics, Measurement of growth, synchronous and Diauxic growth. [8]
3. Genetic analysis of bacteria: Conjugation mapping. Plasmid biology: Types, Replication (theta mode and rolling circle), partition, incompatibility and transfer; Regulation of gene expression: Lac operon. [8]
4. Environmental microbiology: Distribution and implications of microbes in air, airborne human diseases. Microbiological analysis of water; Winogradsky column, Presumptive and confirmatory tests; TOC, COD and BOD; Indicator organisms; Water borne human diseases. Waste water treatment systems; Biofertilizers; degradation of xenobiotics. [10]
5. Medical microbiology: Pathogenic properties of Bacteria; Toxins and extracellular enzymes, brief account of major human disease and their bacterial pathogens. [6]
6. Virology: Distinctive properties and ultra-structure of viruses, Nomenclature and classification, Assay of viruses, Viral genome organizations, Viral replication and their regulation in case of TMV and Bacteriophages, Virus related agents: viroids, virusoids, prions and Satellite virus. [8]

Immunology:

1. Immunology**:** Cells and organs of the immune system; Lymphocytes, Antigens, Antibodies, Immunoglobulin classes; Structure of Immunoglobulin G; Polyclonal and monoclonal antibodies; Interferon, Vaccine. [5]
2. Immune diseases**:** AIDS: Human immunodeficiency virus – structure & genomic organization; Hypersensitivity; Autoimmune diseases. SARS, MERS, COVID-19: genomic organisation and infectivity, vaccine. [5]
3. Antigen**-**antibody reactions and its application in Immunodiagnostics**:** Agglutination (Widal test, latex agglutination test, Viral hemagglutination), Immunodiffusion (SRID), ELISA, Skin-prick test, Immunoelectrophoresis, Immunoprecipitation, RIA, Western Blotting, Immunofluroscence, Blood group test. [8]

Practical: [PG-BOT-CC-P-102] (20 marks; 1 credit, 20 classes):
(Practical based on theoretical paper)

Suggested Readings

1. Brock Biology of Microorganisms, by Madigan, Bender, Buckley, Sattley, Stahl. 16th edition, Global Edition, Pearson, 2021.
2. General Microbiology by R.Y. Stanier, JL Ingrahm, ML Wheelis and PR Painter. 5th edition, Palgrave Macmillan.
3. Microbiology: Fundamentals and Applications by RM Atlas. 2nd edition Macmillan, USA.
4. General Microbiology by HG Schlegel. 6th edition, Cambridge University Press.
5. Microbial Physiology by A G Moat and Foster. 4th edition, A John Wiley and Sons, INC, publication.
6. Fundamental Bacterial Genetics by N Trun and J Trempy (2009). Wiley publication.
7. Bacterial Genetics and Genomics by Lori A.S. Snyder, 1st Edition, 2020, CRC Press, Taylor & Francis Group.
8. Microbial Genetics by Maloy, J E Cronan and D Friefelder. 2nd edition, Jones and Bartlett publishers, INC.
9. Introduction to Modern Virology by NJ Dimmock, A J Easton and K N Leppard (2016), 7th edition, Wiley Blackwell.
10. Basic Virology by EK Wagner, MJ Hewlett, DC Bloom and D Camerini. 7th edition, Wiley Blackwell.
11. Principles of Fermentation Technology by P F Stanbury, A Whitaker and SJ Hall. 3rd edition, Butler Worth Heinemann.
12. Microbiology by Prescott L, Harley J, Klein D. (2008). 7th edition, McGraw Hill Education.
13. Microbial Interactions in Agriculture and Forestry Vol. 2, NS SubbaRao and YR Dommergues (2002). Oxford & IBH.
14. Immunology by Khan, Pearson (2009). 1st edition, Pearson Education, India.
15. Text book of Immunology by A. Chakraborty (2006). 1st edition, Oxford University Press.

PG-BOT-CC-T-103: Phycology and Bryology:
Theory (60 marks; 3 credits, 60 Lecture hours)

Course Objectives:

The course aims to have understanding of modern concept and classification of algae and bryophytes and the process of evolution in a broad sense. Ecological significance and economic importance of both groups are also had to study.

Course Learning Outcomes:

After completion of the course the learners will be able to:

- To describe the origin, classification and different features of algal group and its ecological and economical importance.
- To describe classification, phylogeny and role of Bryophytes in ecosystem.
- It will create awareness on the threats to biodiversity and sensitize towards the Biodiversity Conservation for sustainable development

Phycology:

1. Modern concept and Classification of algae based on chloroplast ultrastructure, pigments, molecular phylogeny. Origin and evolution in algae. Salient features of Cyanobacteria, Chlorophyta, Heterokontophyta (Xanthophyceae, Bacillariophyceae, Phaeophyceae) and Rhodophyta with special emphasis on evolutionary tendencies and phylogeny. Reason for exclusion of Heterokontophyta and Cyanobacteria from algal group. Endosymbiotic theory of origin of chloroplasts. Streptophyta and the origin of land plant. [18]
2. Ecological significance of Algae: Algal bloom, Bioluminescence, Red tides, El Nino. [4]
3. Fossil Algae: Brief account of fossil algae. Economic importance of fossil algae [4]
4. Economic and applied aspect of Algae: Food, Biofertilizer, Industrial utilization and Biotechnological implications. [8]

Bryology:

1. Recent trend in classification of Bryophytes and outline on a recent classification system of liverworts, hornworts and mosses. [4]
2. Sporophyte organization and its evolutionary significance in bryophytes: Peristome structure and its taxonomic significance. [6]
3. Phylogeny: Evolutionary significance and interrelationships; recent concepts on evolution of the three lineages (liverworts, mosses and hornworts). [6]
4. Role of Bryophytes in Ecosystem Dynamics and in global carbon budget; threats and vulnerability; Metabolic chemistry of Bryophyte, Ecological significance of Bryophytes

with special reference to environmental monitoring and restoration; Bryophytes as pollution indicator and as phytoremediator; Economic importance of Bryophytes. [10]

Practical [PG-BOT-CC-P-104] (20 marks; 1 credit, 20 classes):
(Practical based on theoretical paper)

Suggested Readings

Phycology:

1. Phycology (4th Edition) R.L. Lee, Cambridge University Press, 2008.
2. Algae- An introduction to Phycology- C Van den Hoek, DG Mann, HM Janes, Cambridge University Press, 1995.
3. Hand Book of Microalgal culture. Ed by A. Richmond. Blackwell Publishing House, 2003.
4. Algae- Anatomy, Biochemistry and biotechnology-L. Barsanti & P. Gualtieri. Taylor & Francis, 2006.
5. Molecular Biology of Cyanobacteria- DA Bryant. Kluwer Academic Publisher, 1995.
6. Photosynthesis in Algae- W. D. Larkman, E. Douglass & J A Raven, Kluwer Academic Publishers.
7. Algal Ecology- Fresh Water Benthic Ecosystems. Ed by R. J Stevenson, ML Bothwell, R.L. Lowe, Academic Press, 1996.
8. Ecology of Cyanobateria-Their diversity in time and space- B A Whittan, M Potts. Kluwer Academic Publishers.
9. Origin of algae and their plastids. Ed. D Bhattacharya, Springer Wien, New York.
10. Biology of Blue Green Algae- NC Carr& BA Whitton, Berkley: University of California Press, 1973.

Bryophyte:

1. Introduction to Bryophytes, Cambridge University Press, Edited by Alain Vanderpoorten and Bernard Goffinet.
2. Bryophyte Biology, 2nd Edition, Bernard Goffinet, Edited by A. Jonathan Shaw.
3. Bryophyte Ecology, edt. A. Smith, Springer Science &Business,Media, 2012.
4. Bryophyte Ecology. Glime, J. M. Houghton: Michigan Technological Univ., 2007.
5. Bryophytes and Lichens in a changing environment. Bates, J. W., and A. M.Farmer, eds. Oxford: Clarendon, 1992.
6. Handbook of Indian Mosses, H. C. Gangulee, Amerind Pub. Co., 1985.
7. Biology of Bryophytes, eds. R.N. Chopra and P.K. Kumra, New age International publisher, 2005.

PG-BOT-CC-T-105: Pteridophytes and Gymnosperms
Theory (60 marks; 3 credits, 60 Lecture hours)

Course Objectives:

The course aims to have understanding of classification, origin and evolutionary aspect of Pteridophytes and Gymnosperm. Ecological significance and economic importance of both groups are also had to study.

Course Learning Outcomes:

After completion of the course the learners will be able to:

- To describe the general characteristics of pteridophytes and gymnosperm with special to their classification, origin & evolution, phytochemistry.
- Understanding of ecological and economical significance.
- Determine the concept of Progymnosperms and its evolutionary significance.

Pteridophytes:

1. Pteridophyta: Introduction, general characteristics, outline of systematic treatments of Pteridophytes; origin and evolution (Anthocerotan theory and algal origin); distribution of extant and extinct groups in time and space. [6]
2. Telome theory and its significance, Enation theory in the light of origin of microphyll, Stelar evolution in Pteridophytes. Soral evolution in ferns, Evolution of Sporangium, indusium and annulus. [6]
3. Characteristic features, geological distribution, evolutionary trends of Rhyniopsida, Zosterophyllopsida, Trimerophytopsida, and early Lycopsida. [5]
4. Types of spore and induction of spore germination, gametophyte types, biochemical aspects of gametophyte differentiation; phytochemistry of pteridophytes. [5]
5. Polyploidy, apospory, apogamy- factors inducing apospory and apogamy; Sexuality in homosporous pteridophytes with special reference to antheridogens activity (chemical nature and mode of action). [6]
6. Ecology and Economic importance - Economic importance of Pteridophytes: as garden plants, as food/food supplements, as medicine, as other useful items. [4]

Gymnosperms:

1. Concept of progymnosperms and its evolutionary significance. [4]
2. General features of gymnosperms; Current concepts on classification of Gymnosperms; Distribution of extant taxa in time and space; Distribution of extant members of Gymnosperms in India. [8]
3. General account on the morphology, anatomy, reproduction, evolutionary trends and molecular phylogeny of the following groups:
   a) Cycadales, b) Coniferales and c) Gnetales. [8]
4. Karyology, phytochemistry and biotechnology of important taxa; endangered and endemic taxa and their conservation status; Gymnosperms as a source of wood, resins, essential oils, food and drugs. [8]

Practical: [PG-BOT-CC-P-106] (20 marks; 1 credit, 20 classes)

(Practical based on theoretical paper)

Pteridophyte:

Field works; Submission of field and laboratory records including permanent slides; collection and preservation of common taxa (Maximum 10).

Gymnosperms:

Field works; Submission of field and laboratory records including permanent slides; collection and preservation of common taxa (Maximum 10).

Suggested Readings

Pteridophyte:

1. Dyer A. F. (1979). The Experimental Biology of Ferns. Academic Press, London.
2. Gifford E. M, Foster A.S. (1989). Morphology and evolution of Vascular plants, (3rd Edn). W H. Freeman & Co.
3. Kubitzki K. (1976). The families and Genera of Vascular plants: Vol. I Pteridophytes. Vikas Publishing House.
4. Rashid A. (1976). An Introduction to Pteridophytes. Vikas Publishing House.
5. Sporne K.R. (1986). Morphology of Pteridophytes. Hutchinson University Library, London.
6. Surange K.R. (1966). Indian Fossil Pteridophytes. Council of Scientific and Industrial Research.
7. Louis J.D. (1977). Evolutionary patterns and processes in ferns: Advances in Botanical Research. Scott. Studies in Fossil Botany. Haffner publications.
8. Chandra S. & Srivastava M. (2003). Pteridology in the New Millennium. Khuwar Acad. Publishers
9. Stewart W.N. & Rothwell G.W. (2005). Paleobotany and the Evolution of Plants, (2nd Edn.) Cambridge University Press.
10. Sharma O.P. (2006). Text book of Pteridophyta. Macmillan India Ltd., New Delhi.
11. Ranker T.A. & Haufler C.H. (2008). Biology and Evolution of Ferns and Lycophytes. Cambridge University Press.

Gymnosperms:

1. The Morphology of Gymnosperms. K.R. Sporne (2015). Scientific Publishers- Jodhpur.
2. Morphology of Gymnosperms. John M. Coulter and Charles J. Chamberlain (2019). Alpha Edition.
3. Gymnosperms. S.P. Bhatnagar and Alok Moitra (2004). New Age International (P) Limited publishers, New Delhi.
4. The Gymnosperms. C. Biswas and B.M. Johri (2014). Springer, 1997th edition.
5. Morphology and Evolution of Vascular Plants. Ernest M. Gifford, Adriance S. Foster (1989). W.H. Freeman publishers.
6. The Families and Genera of Vascular Plants. K.U. Kramer, P.S. Green (1990). Springer-Verlag, (Edited by Kubitzki).

PG-BOT-CC-T-107: Indigenous Knowledge of Botany
Theory (60 marks; 3 credits, 60 Lecture hours)

Course Objectives:
This course explores archaeobotanical evidence and crop domestication in ancient India, examines indigenous conservation ethics and traditional ecological knowledge (TEK), traces the evolution of Indian plant taxonomy from Vedic texts to modern institutions, and evaluates traditional Ayurvedic pharmacology alongside its modern applications in phytochemistry, TKDL, and drug discovery.

Course Learning Outcomes:
Upon successful completion of this course, students will be able to:

- Reconstruct ancient agricultural and plant-use practices using archaeobotanical evidence from Harappan and prehistoric sites.
- Assess the role of Traditional Ecological Knowledge (TEK) and sacred groves in biodiversity conservation and sustainable resource management.
- Outline the historical evolution of plant taxonomy in India across Vedic, colonial, and modern institutional eras.
- Apply classical Ayurvedic pharmacological principles (*Tridosha*, *Panchamahabhutas*, *Rasa*, *Guna*, *Veerya*, *Vipaka*) to therapeutic plant applications.
- Evaluate crude herbal drugs using pharmacognostic and phytochemical methods within modern AYUSH and TKDL frameworks.

Unit-1: Botanical Knowledge in Ancient Civilizations in India (12): Scope, objectives and significance of botany in reconstructing ancient plant – human relationships and indigenous botanical knowledge; types and preservation of plant remain; evidence of crop cultivation, food plants, domestication and agricultural practices from major Harappan sites; Archaeobotanical evidence for the use of plants as crop, food, medicine, fuel, timber, fibre, dye and other economic resources from prehistoric and historic India.

Unit-2: Traditional Ecological Knowledge (12): Scope and Concept; Holistic approach of traditional ecological knowledge–ethical and spiritual stewardship, intergenerational oral transmissions, integration with modern science; Role of Indigenous knowledge in biodiversity conservation, healthy environment and sustainable development.

Unit-3: Plant Taxonomy in India (12): History and development of plant taxonomy, Contribution of Charaka in plant taxonomy, Vedic and post-Vedic classification, Contribution of Indian taxonomists in plant science, colonial period and pioneer taxonomists in India, Institutional contributions to plant taxonomy (BSI, CNH, Botanical Gardens).

Unit-4: Medicinal plants of Ancient India (12): Study of plant drugs in the Rigveda and Atharvaveda (1500-500 BCE), including early references to healing herbs and the enigmatic Soma; Charaka Samhita and Sushruta Samhita; concept of Tridosha and Panchamahabhutas; Key ancient medicinal plants-Tulsi, Ashwagandha, Turmeric, Brahmi, Neem, Giloy; Ayurvedic Pharmacology - Rasa, Guna, Veerya, Vipaka.

Unit-5: Ancient Ethnobotany and Pharmacognostic approaches (12): Foundations of ethnobotany, scope and interdisciplinary nature of ethnobotany; Medico-Ethnobotanical survey of sacred groves; Global systems of traditional medicine; role of Indian TKDL; recent applications of AYUSH in daily life; historical development and transition from raw herbalism to modern pharmacognosy; sources of crude drugs and their evaluation; phytochemistry and ancient to modern drug discovery; application of pharmacognosy in daily life.

Practical: [PG-BOT-CC-P-108] (20 marks; 1 credit, 20 classes)
(Practical based on theoretical paper)

Field study (Different Phytogeographical region), Workshop and Microscopic Case Study, Laboratory investigation.

Suggested Readings

1. Kajale, M. D. (1991). Current status of archaeobotanical research in India: A review. In New Light on Ancient Farming: Recent Advances in Ethnobotany and Archaeobotany (pp. 155–189). Academic Press.
2. Padhy, S. (2019). Udbhid Vijnaana: Plant science in ancient India. Chaukhamba Sanskrit Series Office.
3. Parashara. (2000). Vrikshayurveda (S. S. Sarkar, Trans. & Ed.). Asiatic Society. (Original work published c. 1st century BCE).
4. Saraswat, K. S. (1992). Archaeobotanical remains in ancient India. The Palaeobotanist, 40, 514–545.
5. Vishnu-Mittre. (1989). Archaeobotanical studies in India: Preserved plant remains, crop domestication, and economic resources. Indian National Science Academy.
6. Purohit, S.S. and Vyas, S.P. (2008). Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
7. Trivedi P.C. (2006). Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
8. Nelson, M. K., & Shilling, D. (Eds.). (2018). Traditional ecological knowledge: Learning from indigenous practices for environmental sustainability. Cambridge University Press.

Interdecsiplinary Course (PG-BOT-IDC-T-101)
Theory (80 marks; 4 credits, 60+20)
Internal Assessment = 20 (15 internal assessment + 5 class attendance)
End Semester = 60
60 Lecture hours

Course Name: Fundamentals of Plant Science

Course Objectives:

- To develop fundamental knowledge of microbes, algae, fungi, bryophytes, pteridophytes, and gymnosperms.
- To understand the basic principles of plant taxonomy, systematics, ecology, paleobotany, and palynology.
- To familiarize students with plant diseases, environmental conservation, GIS/remote sensing, and global environmental issues.
- To introduce the basic concepts and applications of plant tissue culture and plant biotechnology.

Course Outcomes:

After completing the course, students will be able to:

- Identify and describe major groups of plants, microbes, algae, and fungi and explain their significance.
- Apply basic knowledge of taxonomy, ecology, plant pathology, paleobotany, and palynology in plant-science studies.
- Explain environmental conservation approaches and the applications of GIS and remote sensing in environmental studies.
- Describe basic plant biotechnology techniques, including tissue culture, micropropagation, GM crops, and artificial seeds.

1. Microbes: General characteristics, structure, reproduction and economic importance of Viruses and Bacteria. Common diseases of plants and animals with special reference to HIV, Bird flu, COVID, SARS, TMV, Tungo Virus etc. (7)

2. Phycology: Classification and basic characteristics of major algal groups and application of algae. (6)

3. Mycology and Plant Pathology: Classification and basic characteristics of fungi, Mycosis (types, diagnosis and management); edible and harmful fungi, medicinal prospects of fungi. Basic idea, common plant diseases, management strategies of plant diseases. (9)

4. Archegoniate: Overview, Classification, and ecological and economical significance of bryophytes, pteridophytes and gymnosperms. (8)

5. Plant Systematics: Taxonomy and systematics; taxonomic hierarchy, natural and phylogenetic classification systems, plant nomenclature; Cladistics analysis. (7)

6. Plant Ecology and Environment: Components, population, community, biome; wetlands classification with examples and their Characteristics; environmental laws and environmental movements in India: WWF, IUCN, MAB, Biosphere Reserve; environmental protocols; remote sensing technique and Geographical Information System (GIS), Global warming. (9)

7. Paleobotany & Palynology: Types of fossils, Fossilization process, modes of preservation; Nomenclature, geological time scale, plant life through age (outline), dating methods; importance of plant fossil study, spore/pollen morphology: NPC Classification, applications of palynology. (9)

8. Basic aspects of plant biotechnology: Plant tissue culture and its application. plant regeneration; organogenesis; embryogenesis; micropropagation; GM crops and their uses; artificial seed. (5)

Suggested Readings:

1. Dubey, R. C., & Maheshwari, D. K. (2022). *A textbook of microbiology* (5th ed.). S. Chand Publishing.
2. Lee, R. E. (2018). *Phycology* (5th ed.). Cambridge University Press, 2008.
3. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Cengage Learning.
4. Bhojwani, S. S., & Dantu, P. K. (2013). *Plant tissue culture: An introductory text*. Springer.
5. Singh, G. (2019). *Plant systematics: An integrated approach* (4th ed.). CRC Press
6. Hait, G., Bhattacharya, K., & Ghosh, A. K. (2011). *A textbook of botany* (Vol. 1). New Central Book Agency.
7. Bhattacharya, K., Majumdar, M. R., & Bhattacharya, S. G. (2011). *A textbook of palynology* (3th rev. ed.). New Central Book Agency.