**Department of Botany**
**Chaudhary Charan Singh University, Meerut**

**Syllabus: B. Sc. Botany (Honours) Semester-VII**
**Core Course-XVII: RESEARCH METHODOLOGY**

**Objectives:**

1. To introduce fundamental principles of research, including types, designs, and approaches used in biological sciences.
2. To provide hands-on experience in data collection, analysis, interpretation, and scientific communication.
3. To develop critical skills for framing research questions, hypotheses, and experimental designs.
4. To equip students with tools for conducting literature reviews using digital and print resources.
5. To train students in scientific writing, referencing, plagiarism checking, and intellectual property rights.
6. To encourage ethical practices and promote problem-solving through scientific investigation aimed at societal benefit.

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

1. Describe the key concepts, types, and methodologies of research in biological sciences.
2. Formulate research questions and hypotheses, and design appropriate experimental or survey-based studies.
3. Conduct comprehensive literature reviews, identify research gaps, and synthesize existing knowledge.
4. Collect, analyze, and interpret qualitative and quantitative data using appropriate statistical or software tools.
5. Write scientific reports, proposals, reviews, and thesis documents using correct referencing and citation styles.
6. Demonstrate ethical research conduct, understand plagiarism, and appreciate the basics of intellectual property rights.

| | |
|---|---|
| Credit: 04 | Course code: |
| Max. Marks: 100 (25+75) | Min. Passing Marks: 36 |
| Total number of Lectures : Tutorials : Practicals (hours per week): 4:0:0 | |

| Unit | Topic | No. of Lectures (60 h) |
|---|---|---|
| I | **Basic Concepts of Research**<br>Objectives, Research Methods vs Methodology, Types of Research- Quantitative vs Qualitative, Analytical vs Descriptive, Basic vs Applied, Field Research, Search engines, Literature-review and its consolidation | 10 |
| II | **Research Design, Data Collection and Analysis**<br>Conceptualization a research problem, Developing a research model, Validation of the proposed model with standard procedures and attributes, Experimental design, and implementation, Observation and Data acquisition, Methods of data collection, Data quality check, Processing and Analysis Strategies; Data presentation (Tables and Figures), Interpretation | 20 |
| III | **Ethical Issues**<br>Intellectual Property Rights, Copy Right, Plagiarism, Commercialization and Royalty | 15 |

| | | |
|---|---|---|
| IV | **Report Writing**<br>Technical Research writing (Dissertation/ Reports/Research/Review papers), Citations, Acknowledgements, Research Grants/ Fellowships, Bibliography | 15 |

**Essential Readings:**


1. Wadhera, B.L. (2002). Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, Universal Law publishing.
2. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
3. Anthony, M, Graziano, A.M. and Raulin, M.L. (2009). Research Methods: A Process of Inquiry, Allyn and Bacon.
4. Kothari, C.R. (2014). Research Methodology: Methods and Techniques, 2nd edition, New Age International (P) Ltd.,
5. Walliman, N. (2011). Research Methods- The Basics. Taylor and Francis, London, New York, USA.


**Suggested Readings:**


1. Coley, S.M. and Scheinberg, C.A. (1990). "Proposal writing". Stage Publications.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Cresswell, J.W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th edition). SAGE Publications Inc.
4. Rao, G.N. (2018). Biostatistics & Research Methodology. Pharmamed Press.
5. Gary J. Burkholder, G.J., Cox, K.A., Crawford, L.M. Hitchcock, J.H. (2019). Research Design and Methods: An Applied Guide for the Scholar-Practitioner. SAGE Publications, Inc.
6. Mukherjee, S.P. (2019). A Guide to Research Methodology: An Overview of Research Problems, Tasks and Methods. CRC Press
7. Flick, U. (2020). Introducing Research Methodology: Thinking Your Way Through Your Research Project. SAGE Publications Ltd.


| **Syllabus: BSc Botany (Honours) Semester-VII** | | |
|---|---|---|
| **Core Course XVIII: Bioinstrumentation** | | |
| **Objectives:** The main objectives of this course are to:<br>1. Enrich the student intelligentsia in all the biological observations which are explainable in terms of physical principles.<br>2. Emphasize the working skill in basic and advanced analytical instruments<br>3. Enhance the ability of understating and working methods of various instruments.<br>**Course Outcomes:** After successful completion of the course, students will be able to:<br>1. Understand the analytical techniques and the principles of equipment used in different fields.<br>2. Have complete insight in these techniques for the possible applications in various research areas.<br>3. Handle basic and advanced instruments with trouble shooting in the biological and medical industries.<br>4. Increase the knowledge on result output analysis and interpretations.<br>5. Comprehend the impact of hazardous material and handling of the materials. | | |
| Credit: 04 | Course code: | |
| Max. Marks: 100 (25+75) | Min. Passing Marks: 36 | |
| Total number of Lectures : Tutorials : Practicals (hours per week): 4:0:0 | | |
| **Unit** | **Topic** | **No. of Lectures (60 h)** |
| I | **Physical techniques of separation:** Basic principle, types of centrifugations, types of centrifuges and biological applications of centrifuge. Analytical problems. | 12 |

| | | |
|---|---|---|
| | Floral architecture (transitions between symmetrical and asymmetrical flowers,) role of pollination systems (any two examples), | |
| II | Phenology, Sexual systems, (monoecy, dioecy, hermaphroditism, gynomonoecious, andromonoecious etc.) cryptic sexuality- resource allocation and reproductive allocation, evolution from solitary flowering to inflorescence, floral attractants, and rewards (pollen, nectar, scent, colour). | 15 |
| III | **Pollination Ecology**<br>Pollination syndromes, (transitions from generalized and specialized pollination system, including mutualistic and non-mutualistic interactions with two examples each), pollinator guilds (concept with two examples); ambophily, pollen banks, pollen mediated gene flow, mating systems, Factors affecting pollen-pistil interactions (abiotic, biotic, and anthropogenic); inbreeding and outbreeding depression; resource allocation. | 15 |
| IV | **Seed Ecology**<br>Dispersal mechanisms (primary and secondary with two examples), viability, dormancy, germination; seedling recruitment; natural seed banks and species survival, seed shadow, seed mediated gene flow. | 10 |
| V | **Reproductive Ecology- Challenges and Contemporary Issues**<br>Impact of climate change on sexual reproduction, global pollinator crisis and pollination failure; crop yield reduction, habitat fragmentation and altitudinal shifts; impact of invasive species on native plants and pollinators, Effect of pollution on reproductive biology of plants | 10 |

| **Syllabus: B. Sc. Botany (Honours) Semester-VII** | | |
|---|---|---|
| **Core Course- Practical VII** | | |
| **Objectives:** To Perform at least 10 exercises from each part.<br>**Course Outcomes:** After performing experiments from each units, the students will be able to gain practical knowledge and skills in | | |
| Credit: 04 | Course code: | |
| Max. Marks: 100 (25+75) | Min. Passing Marks: 36 | |
| Total number of Lectures : Tutorials : Practicals (hours per week): 4:0:0 | | |
| **Unit** | **Topic** | **No. of Lectures ( 60 h)** |
| I | **PRACTICALS: Research Methodology**<br>Laboratory rules and regulations – Safety principles and Handling<br>pH measurement of samples using pH meter<br>Preparation of buffer-Phosphate Buffer<br>Centrifugation-Separation of organelles using Centrifugation<br>Paper Chromatography- Separation of plant pigments<br>Spectrophotometric method-Estimation of chlorophyll content<br>Thin Layer Chromatography for separation of amino acids<br>Analysis of Heavy metals from drinking water through AAS (demo) | 45 |

| | | |
|---|---|---|
| II | **Agricultural Microbiology**: Breeding for virus resistance, natural mechanism and transgenic strategies, relevance to Indian agriculture. BNF, Mycorrhiza, Microbial Mineralization, Biocontrol of plant diseases.<br>**Environmental Microbiology**: Biodegradation, Bioremediation, Microbes in nanotechnology, Biosensors. | 15 |
| III | **Host Parasite Interaction:** Recognition and Entry process of bacteria and virus into animal and plant host cells, Alteration of host cell and viruses, Virus induced cancers, Two component signalling systems, Chemotaxis, Quorum sensing. | 15 |
| IV | **Antimicrobial Substances**: Complement system, Interferons, Iron-binding proteins, Antimicrobial peptides.<br>**Resistance to Antimicrobial Drugs**: Mechanism of resistance in microbes, Antibiotic misuse,. Origin and evolution of virus like- covid-19. | 15 |

**Essential Readings:**


1. Salyers, A. A., Whitt, D. D. (2000). Microbiology: Diversityand the Environment.1st Edition.
2. Pommerville, J. C. (2018). Fundamentals of Microbiology. 11th Edition


**Suggested Readings:**


1. Pelczar (Jr.), M. J., Chan, E.C.S. and Krieg, N. R. (2016). Microbiology. 5th Edition.
2. Tortora, F. (2017). Microbiology an introduction. 12th edition.
3. Willey, J., Sandman, K., Wood, D. (2020). Prescott'sMicrobiology. 11th Edition.


**Syllabus: B. Sc. Botany (Honours) Semester-VIII**

**Elective Course3b: REPRODUCTIVE ECOLOGY**

**Objectives**

1. To acquaint students about the diversity in floral architecture, floral rewards so that they can correlate the concepts with breeding mechanisms.
2. To help them appreciate the adaptive significance of various traits associated with pollination, seed dispersal and seedling recruitment.
3. To sensitize students towards challenges faced by flowering plants on account of climate change and other anthropogenic activities.
4. To build on the concepts of inbreeding and outbreeding depression, seed ecology and resource allocation.

**Course Outcomes**

After completing this course students will:

1. Become familiar with interesting concepts involved in understanding of reproductive ecology such as floral rewards, plant-pollinator interactions and pollinator guilds.
2. Have an understanding of intricacies and complexities involved in the reproductive success.
3. Will have background knowledge and an opportunity to utilize this knowledge to undertake interdisciplinary research.in conservation biology and other allied fields such as plant breeding.

| | |
|---|---|
| Credit: 04 | Course code: |
| Max. Marks: 100 (25+75) | Min. Passing Marks: 36 |
| Total number of Lectures : Tutorials : Practicals (hours per week): 4:0:0 | |

| Unit | Topic | No. of Lectures (60 h) |
|---|---|---|
| I | **Floral Ecology** | 10 |

| | | |
|---|---|---|
| II | **Microscopy**: Resolution, magnification and Numerical aperture of microscope. Compound, electron, dark field, bright field, transmission electron and scanning electron microscopy. | 12 |
| III | **Chemical techniques of separation**: Basic principle, types of conventional chromatography, Paper chromatography, thin layer chromatography, Column chromatography, Gas Chromatography, GLC. HPLC; biological applications of chromatography. | 15 |
| IV | **Spectroscopy**: Properties of light relevant to spectroscopic studies, principles of light absorption and emission. Basics of UV-Vis spectroscopy, Instrumentation and application Fluorescence spectroscopy Instrumentation and application Basics of IR spectroscopy and Mass Spectrometry. | 15 |
| V | **Electrophoresis:** Horizontal and vertical electrophoretic units, native, SDS-PAGE, Agarose gel and 2-D gel electrophoresis. DNA, RNA and protein Blotting techniques. | 16 |

**Essntial Readings:**


1. Instrumental methods of chemical analysis – P.K. SharmaPhysical Biochemistry, 2nd edition, W.H. Freemanand Co., USA - David Friefelder, (1983)
2. Vogel's Textbookof Quantitative Chemical Analysis, 5th Edition, ELBS, England- G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney, (1991)


**Suggested Readings:**


1. The Elements of Physical Chemistry, Oxford University Press-P.W. Atkins, (1996)
2. Biophysical chemistry – Upadhyay Upadhyay and Nath (2009) 6 Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata (2003). McGraw Hill


| **Syllabus: B. Sc. Botany (Honours) Semester-VII** | | |
|---|---|---|
| Course Code : | **Elective Course-3a : Fundamental Microbiology** | |
| **Course Objectives**: The objective of this course is to make students aware about microbial world and its diversity along with their skill enhancement in microbial application for human welfare and development.<br>**Course Outcomes:** By the end of the course, the students should be able to:<br>1. Address the concepts of microbes and their diversity.<br>2. Evaluate methods for isolation, purification and cultivation of microorganisms from different sources.<br>3. Understand classification and growth patterns of bacterial cell.<br>4. Differentiate between virus, viroids, virusoids and prions. | | |
| Credits : 4 | Core Compulsory | |
| Max Marks : 30+70 | Min. Passing Marks : | |
| Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0 | | |
| **Unit** | **Topic** | **No. of Lectures (60 hrs)** |
| I | **Introduction**: Viral genomics and viral proteomics. Viral phylogeny. Viral database. A general account of archaea classification including 16s r-DNA sequencing. Evolutionary aspects of plant microbe interaction.<br>**Growth & Nutrition**: Microbial nutrition, growth kinetics and metabolism | 15 |

| | | |
|---|---|---|
| II | **PRACTICALS- Bio-instrumentation**<br>To study the principle and applications of centrifugation for separation of biological materials.<br>To study the working and applications of a compound microscope.<br>To study the use of micropipettes and practice accurate pipetting.<br>To study the principle and applications of electrophoresis for separation of biomolecules.<br>To study the use of a haemocytometer for cell counting.<br>To study the principle and use of an autoclave and laminar airflow cabinet for sterilization and aseptic work.<br>To study the working and applications of a water bath and incubator.<br>To study the use of an analytical balance and conductivity meter in biological experiments. | 45 |
| III | **PRACTICALS: Microbiology**<br>1. Culture media preparation and sterilization<br>2. Isolation and maintenance of pure cultures using common microbiological media<br>3. Phylloplane microflora- visualization and isolation.<br>4. Rhizosphere microflora- visualization and isolation.<br>5. Examination of gram staining of bacteria from curd and rood nodules<br>6. Methods of isolation and culturing of bacteria colony characters; microscopic observations. | |
| IV | **PRACTICALS: Reproductive ecology**<br>1. To study diversity in floral architecture (type of soil, temperature, humidity etc. to be mentioned).<br>2. To carry out histochemical tests in pollen (proteins, lipids, starch).<br>3. To study the structure of nectary of any flower available in the campus (through section, whole mount).<br>4. To analyse nectar volume and composition (using refractometer/chromatography)<br>5. To study through temporary preparations - types of stigma (dry and wet) and style (hollow and solid).<br>6. To calculate pollen to ovule ratio and predict the mating system using established literature.<br>7. Study of species survival (ovule to seed ratio).<br>8. Effect of antibiotics on pollen germination. | |

**Suggested Readings:**

Tandon, R., Shivanna, K.R., Koul, M. (Eds) 2020. Reproductive Ecology of Flowering Plants: Patterns and Processes. Springer LINK

Shivanna, K.R., Tandon, R. 2014. Reproductive Ecology of Flowering Plants: A Manual. Springer LINK

Lovett-Doust, J., Lovett-Doust.L. 1988. Plant Reproductive Ecology: Patterns and Strategies: Oxford University Press, USA.

Rustagi, A., Chaudhry, B. (Eds) 2022. Plant Reproductive Ecology-Recent Advances. Intech Open, London, U.K

Mangla,Y., Khanduri, P., Gupta, C.K. 2022. Reproductive Biology of Angiosperms: Concepts and Laboratory Methods.Cambridge University Press.

Spencer C.H. Barrett & Christopher G. Eckert (1990) Current issues in plant reproductive ecology. Israel Journal of Botany 39:1-2, 5-12.

Nicolson, S.W., Wright, G.A. 2017. Plant-pollinator interactions and threats to pollination: perspectives from the flower to the landscape. Functional ecology 31:22-25
Hicks, L. 2020. Flowers colors are changing in response to climate change; Pigment changes can make plants less attractive to pollinators. Science News.

1. Study of reproductive structures of different genera of fungi.
2. Study of fungal physiology in pure colonies – characterization of fungal colonies.

Study of as many as possible viral, bacterial and fungal diseases of crop plants (cereal, vegetable, fruit, and plantations) from surrounding habitats in Meerut region.

| **Syllabus: B. Sc. Botany (Honours) Semester-VIII** | | |
|---|---|---|
| **Core Course-XIX: Algae & Bryophytes** | | |
| **Objectives:** To study phylogeny and inter-relationships of Algae & Bryophyta.<br>**Course Outcomes:**<br>1. Students will have clear idea of the characteristics of the important plant groups.<br>2. Concepts in the evolution of plants will be clear to students. | | |
| Credit: 04 | Course code: | |
| Max. Marks: 100 (25+75) | Min. Passing Marks: 36 | |
| Total number of Lectures : Tutorials : Practicals (hours per week): 4:0:0 | | |
| **Unit** | **Topic** | **No. of Lectures (60 h)** |
| I | Algae: A general account, Phylogenetic definitions, Phylogeny, Classification and Cyanophyta | 15 |
| II | Chlorophyta, Charophyta, Phaeophyta ecological and economic importance. | 15 |
| III | Rhodophyta with ecological and economic importance. | 15 |
| IV | **Bryophyta**: A general account, Phylogenetic definitions, Phylogeny, classification and apomorphies of Hepaticae | 10 |
| V | **Bryophyta**: Anthocerotae, and Musci with ecological and Economic Importance. | 05 |

**Suggested Readings**:

Agashe, S. N. (1995). Paleobotany. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
Arnold, A. C. (2005). An Introduction to Paleobotany. Agrobios (India), Jodhpur.
Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
Biswas, C. and Johri, B. M. (1997). Gymnosperms. 4 Narosa Publishers, NewDelhi.
Bold, H.C. and Wynne, M. J. (1985). Introduction to the algae; Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey.
Cavers, F. (1976). The inter relationships of the bryophyte. S.R. Technic, Ashok Rajpath, Patna.
Chapman, V.J. and Chapman D.J. (1975). The algae. 2nd Edition, Mac. Millan Publ. Inc. New York.
Chopra, R. N., and Kumar, P. K. (1988). Biology of Bryophytes. John Wiley and Sons, New York (NY).
Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi.
Hoek, C. van den, Mann, D. G. and Jahns, H. M. (1995). Algae: An introduction to Phycology. Cambridge University Press, UK.
Kashyap, S. R. (1929). Liverworts of the Western Himalayas and the Punjab Plain. Part1, Chronica Botanica, New Delhi.

Kashyap, S. R. (1932). Liverworts of the western Himalayas and the panjab plain (illustrated). Part 2. The Chronica Botanica, New Delhi.
Parihar, N.S. (1976). Biology and morphology of the Pteidophytes. Central Book Depot.
Parihar, N. S. (1980). Bryophytes: An introduction to Embryophyta.Voll,Bryophyta, Central Book Depot.
Puri, P. (1981). Bryophytes: Morphology. Growth and Differentiation. Atmaram and Sons, New Delhi.
Prescott, G. W. (1969). The algae: A review. Nelson, London.
Rashid, A. (1999). An Introduction to Pteridophyta.Vikas Publishing House Pvt. Ltd., New Delhi.
Ramanujan, C.K.G. (1970). Indian Gymnosperms in time and space. Today & Tomorrow 's Printers & Publishers.
Round, F.E. (1981). The Ecology of Algae. Cambridge University Press, Cambridge.
Sporne, K.R. (1965). Morphology of Gymnosperms. Hutchinson University Library.
Sporne, K.R. (1986). The morphology of Pteridophytes. Hutchinson University Press, London.
de Queiroz, K., & Cantino, P. (2020). International Code of Phylogenetic Nomenclature (PhyloCode) (1st ed.). CRC Press. https://doi.org/10.1201/9780429446320
de Queiroz, K., Cantino, P., & Gauthier, J. (Eds.). (2020). Phylonyms: A Companion to the PhyloCode (1st ed.). CRC Press. https://doi.org/10.1201/9780429446276.

| Subject : B.Sc. Botany (Honours) Semester-VIII | | |
|---|---|---|
| Core Course Title : Plant Systematics | | |
| **Course Objectives**:This course aims to add to understanding of the students about basic concepts of plant systematics, clades of Angiosperms **Course Outcomes**: The students will be learning<br>1. What do we mean by systematics & Cladistics? What are different Types of clade? How to name the clades. Principles &Protologue of Phylocode<br>2. What are Characteristics, and Classification of Angiospermic clades<br>3. What are the sources of variations and how speciation takes place?<br>4. What are the data for molecular systematics. How phylogenetic analysis is carried out. What is DNA barcoding. | | |
| Credits : 4 | | Core Compulsory |
| Max Marks : 25+75 | | Min. Passing Marks : 36 |
| Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0 | | |
| **Unit** | Topic | No. of Lectures (60 hrs) |
| I | **Cladistics**: Systematics (concept & definitions), Phylogeny & Ontogeny. Concept of Clade, Grade, Clan, Lineages, & Component of Cladogram. How to read the tree/Cladogram. Clades at different hierarchical level, Identification of Clade, Crown clade, and Total Clade.<br>**Evolutionary concepts**: monophyly, paraphyly, polyphyly, plesiomorphy, apomorphy, anagenesis, cladogenesis, homology, analogy, homoplasy, parallelism and convergence, synapomorphy, symplesiomorphy and Semaphoront. Apomorphies in Angiosperms. | 10 |

| | | |
|---|---|---|
| II | **Phylocode:** Preamble & Principles (with explanation) of Phylocode. Formulation & Illustrations of Phylogenetic definitions and naming of clades, Specifiers, qualifying clause. Parts of protologue (complete name/clade entry). Comparison of Traditional & Phylocode.<br>**Clades in Angiosperm**: ANA/ANITA grade, Concept of Paleoherbs; Phylogenetic definitions, Phylogeny and Characteristics/apomorphies of following clades: Mesangiospermae; Pan-Angiospermae; ApoAngiospermae; Angiospermae; Magnoliidae; Monocotyledoneae, Tricolpatae, Eudicotyledoneae, Superrosidae; and Superasteridae. | 20 |
| III | **Variation & Speciation**: Isolation: Definitions, classification & Mechanism. Variations: Definitions, Types & mechanism. Speciation: Definitions, causes, types & mode. Origin & Evolution of Flowering Plants. | 15 |
| IV | **Data for Plant Systematics**: Morphological & Molecular data. Structure and Role of Chloroplast Genome in Plant Systematics; Mitogenomics and Mitochondrial Genome in Plant Systematics; Nuclear Ribosomal DNA: Structure and uses in Systematics. DNA barcoding. | 15 |

**Suggested Readings**:


Christenhusz, M. J. M., Chase, M. W. and Michael F. F. (2017). Plants of the World: An Illustrated Encyclopedia of Vascular Plants. University of Chicago Press.

de Queiroz, K., & Cantino, P. (2020). International Code of Phylogenetic Nomenclature (PhyloCode) (1st ed.). CRC Press. https://doi.org/10.1201/9780429446320

de Queiroz, K., Cantino, P., & Gauthier, J. (Eds.). (2020). Phylonyms: A Companion to the PhyloCode (1st ed.). CRC Press. https://doi.org/10.1201/9780429446276.

Angiosperm Phylogeny Group, (2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnaean Society, 181: 1-20.

Davis, P.H., & Heywood V. H. (1965). Principles of Angiosperm Taxonomy. Oliver & Boyd. Edinburgh.

Jones, S.B., & Luchsinger, A.E. (1987). Plant Systematics. 2nd Edition. McGrawHill Book Company. New York.

Judd, W. S., Campbell, C. S., Kellog, E. A., Stevens, P. F & Donoghue, M. J. (2015). Plant Systematics – A phylogenetic approach. Sinauer Associates, Inc, Massachusetts, USA

Radford, A.E., Dickinson, W.C., Massey, J. R. & Bell, C.R. (1974). Vascular Plant Systematics. Harper & Row. New York.

Simpson, M. G. (2006). Plant Systematics. Elsevier Academic Press, California, USA.

Singh, G. (2019). Plant Systematics: An Integrated Approach (4th Edition) CRC Press of Tailor and *Taylor* & Francis.

Soltis, D. E., Soltis, P.S., Endress, P. K. & Chase, M.W. (2017). Phylogeny and Evolution of Angiosperms. Sinauer Associates, Inc, Massachusetts, USA/ University of Chicago Press.

Stace, C.A. (1989). Plant Taxonomy and Biosystematics. Edward Arnold, London.

Stuessy, T. F. (2002). Plant Taxonomy. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Takhtajan, A. (1969). Flowering Plants, Origin and Dispersal. Tr. Jeffery, Edinburgh.

Takhtajan, A. (1987). Flowering Plants, Origin and Dispersal: the cradle of the Angiosperms revisited. pp. 26-31 in Whitmore, T.C. Biogeographical Evolution of the Malay Archipelago. Clarendon Press, Oxford.

Radford, A.E. (1986). Fundamental of Plant Systeamtics. Harper and Row, Publisher, Inc.

| Elective Course Title : 4(a) **Applied Mycology** | |
|---|---|
| **Objectives:**<br>**1.** To understand the detailed structure of fungus **2.** To study the evolution of fungi.<br>**3.** To study the economic importance of fungi **Course Outcomes:**<br>1. Students will understand the every aspects of fungi.<br>2. Students will able to endeavor the arena of mushroom cultivation and be the future entrepreneur.<br>3. Students will able to use locally available strains of fungi as biocontrol agents. | |
| Credits : 4 | Core Elective |
| Max Marks : 25+75 | Min. Passing Marks : 36 |
| Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0 | |

| Unit | Topic | No. of Lectures (60 hrs) |
|---|---|---|
| I | **Diversity of fungi** : General account of fungi, classification of fungi and contribution of scientists, Cultivation, isolation and selection of some useful fungi Common genera – *Saccharomyces, Rhizopus, Penecillium, Erysiphe, Neurospora, Agaricus* | 15 |
| II | **Detailed account of fungi**: Isolation and multiplication of mycorrhizae, role in crop productivity and forestry. Phosphate solubilizing fungi. General account of mushroom cultivation –*Agaricus bisporus, Volvariella volvaceae, Calocybe indica.* Medicinal and nutritional value of edible and medicinal mushroom Effect of environmental, nutritional and chemical factors on mushroom cultivation. Genetic improvements in mushroom. | 15 |
| III | **Role of fungus in Biotechnology**: Fermentation process and biomass production of fungi, growth kinetics, fermenter systems scale up. Yeast genome: Genetic analysis of yeast, Baker's yeast, food and feed yeast, industrial products (glycerol, adhesive, bio-polymer from yeast). **Economic importance**: Fungi in industry, Fungi in medicine, Fungi in agriculture, Fungi as food. | 15 |
| IV | **Fungal pathology**: Disease caused by fungi in plants, Fungi as human and animal parasites, Nematophagus fungi, entomogenous fungi, Exploitation of biocontrol agents by genetic manipulation. Management of fungal diseases. | 15 |

**Essential Readings**:


1. Alexopoulos, C.J., Mims, C.W. and Blaclwell, M. (2007). Introductory
2. Mycology. Fourth Edition,Wiley India Pvt. Limited.
3. Mehrotra, R.S. (2017). Plant Pathology. 3rd Edition, McGraw-Hill Education, New Delhi.


**Suggested Readings**:


1. Okafor, N. and Okeke, B.C. (2018). Modern Industrial Microbiology and Biotechnology. 2nd Edition, CRC Press, Boca Raton
2. Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi & Their Allies, Second Edition. Mac Millan Publishers Pvt. Ltd., Delhi, India
3. Webster, J. and Weber, R. (2007). Introduction to Fungi. Third Edition, Cambridge University Press, Cambridge and New York.
4. Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 10th Edition, McGraw-Hill, USA

## Syllabus: B. Sc. Botany (Honours) Semester-VIII
## Elective Course-4b: Plant Genomics

**Objectives**

1. To introduce methods of gene identification, isolation and synthesis.
2. To explain genetic, physical and functional genome maps.
3. To provide knowledge of major genome-sequencing methods.
4. To introduce functional genomics and gene-silencing methods.
5. To explain genome editing and the organization of important plant genomes.

**Course Outcomes**

1. Describe different methods used to identify and isolate genes.
2. Explain molecular mapping, comparative genomics and synteny.
3. Compare different generations of genome-sequencing technologies.
4. Explain gene silencing, gene knockdown and genome-editing methods.
5. Describe the main features of important plant genomes, pan-genomes and metagenomes.

| Credit: 04 | Course code: |
|---|---|
| Max. Marks: 100 (25+75) | Min. Passing Marks: 36 |

Total number of Lectures : Tutorials : Practicals (hours per week): 4:0:0

| Unit | Topic | No. of Lectures (45 h) |
|---|---|---|
| I | **Gene identification/isolation and synthesis:** Methods of gene identification - Wet-lab methods (RNA-seq, EST/cDNA libraries, functional cloning, use of antibody; transposon tagging), In silico methods (gene prediction, homology-based, comparative mapping). Gene synthesis machines, PCR methods of gene synthesis, synthesis of genomes. | 10 |
| II | **Molecular maps and comparative genomics:** Genetic maps, physical maps, EST or transcript maps, functional maps; comparative mapping, sequence collinearity, micro-collinearity and synteny in maps. | 05 |
| III | **Whole genome sequencing:** Whole genome shotgun and clone-by-clone or hierarchical shotgun sequencing approaches. First generation sequencing (Sanger's dideoxy chain termination method, Maxam and Gilbert's degradation method), Second generation sequencing (Roche 454, Illumina Solexa, ABI SOLiD), Third generation sequencing (PacBio SMRT, Helicos single molecule, Nanopore sequencing). | 10 |
| IV | **Functional genomics:** Introduction to functional genomics, forward and reverse genetics (TILLING, DNA microarray), Post-transcriptional gene silencing (Antisense RNA technology and RNA interference), Gene knockdown (T-DNA, transposon, VIGS), Gene/genome editing (TALENs, ZFNs, CRISPR/Cas) | 10 |
| V | **Green plant genomes:** Green alga (*Ostreococcus tauri*), Bryophytes (*Physcomitrium patens*), Spreading Earthmoss (*Physcomitrium patens*), Thale cress (*Arabidopsis thaliana*), Rice (*Oryza sativa*), Bread wheat (*Triticum aestivum*), Duckweed (*Spirodela polyrhiza*), Fork Fern (*Tmesipteris oblanceolata*).<br>Mitogenome, Plastome, Virome, Pan-genome and Metagenome. | 10 |

**Essential Reading:**


1. Gupta, P. K. (2004). Biotechnology and Genomics. Rastogi Publication, Meerut.
2. Cullis, C. A. ( 2004). Plant Genomics and Proteomics. Agrosciences, New Delhi.

3. Reece, R. J. (2004). Analysis of Genes and Genomes. Agrosciences, New Delhi.

**Suggested Reading:**

1. Brown, T. A. (2007). Genomes, 3/e. Garland Science, New York.
2. Stein (2003). Fundamentals of Protein Biotechnology. Atlas Books, New Delhi.

| **Syllabus: B. Sc. Botany (Honours) Semester-VII** | | |
|---|---|---|
| **Core Course- Practical VII** | | |
| **Objectives:** To Perform at least 10 exercises from each part.<br>**Course Outcomes:** After performing experiments from each units, the students will be able to gain practical knowledge and skills in | | |
| Credit: 04 | Course code: | |
| Max. Marks: 100 (25+75) | Min. Passing Marks: 36 | |
| Total number of Lectures : Tutorials : Practicals (hours per week): 4:0:0 | | |
| **Unit** | **Topic** | **No. of Lectures ( 60 h)** |
| I | **PRACTICALS: Algae & Bryophytes**<br>**1.Identification of specimens**<br>Know the characteristic features and diagrams of:<br>*Chlamydomonas* — unicellular, flagellated green alga<br>*Volvox* — colonial green alga<br>*Spirogyra* — filamentous, spiral chloroplasts<br>*Ulothrix* — unbranched filament with girdle-shaped chloroplast<br>*Oedogonium* — filamentous; cap cells<br>*Vaucheria* — coenocytic, siphonaceous alga<br>*Fucus* — brown alga; conceptacles<br>*Polysiphonia* — red alga; complex life cycle<br>**2. Important practical slides/structures**<br>*Chlamydomonas*: eyespot, flagella, chloroplast, pyrenoid<br>*Volvox*: colony and daughter colonies<br>*Spirogyra*: spiral chloroplast and conjugation<br>*Oedogonium*: cap cells and oogonium<br>*Fucus*: conceptacle, antheridia, oogonia<br>*Polysiphonia*: reproductive structures and life cycle<br>**3. Key practical skills**<br>Temporary/permanent slide preparation<br>Microscopic identification<br>Drawing and labelling specimens<br>Recognising vegetative and reproductive structures<br>**Bryophytes — essential practicals**<br>**1. Identification of specimens**<br>*Riccia Marchantia Anthoceros Funaria Polytrichum*<br>**2. Important structures**<br>*Marchantia*: thallus, rhizoids, scales, gemma cups, antheridiophore, archegoniophore<br>*Anthoceros*: horn-like sporophyte, pseudoelaters, spores<br>*Funaria*: protonema, leafy gametophyte, seta, capsule, operculum, peristome teeth | 45 |

| | | |
|---|---|---|
| | *Polytrichum*: leafy shoot, rhizoids, sporophyte and calyptra | |
| II | **PRACTICALS- Plant Systematics**<br>1. Writing of technical descriptions<br>2. Construction of keys.<br>3. Identification of local species using Floras, keys and campus field trips.<br>4. Identification of common families using diagnostic characters. Illustrate diagnostic characters.<br>5. Construction of phylogentic tree based on gene sequences available at NCBI database (each student may be given different gene sequences/taxa).<br>6. Construction of Cladogram on the basis of given characters. | 45 |
| III | **PRACTICALS: Applied Mycology**<br>Applied Mycology — Essential Practicals<br><br>1. To study aseptic techniques and sterilization methods used in fungal culture.<br>2. To prepare and sterilize fungal culture media and study their applications.<br>3. To study the isolation and cultivation of fungi from soil, air, water and plant materials.<br>4. To study colony morphology and microscopic characteristics of common fungi.<br>5. To prepare temporary mounts and study vegetative and reproductive structures of fungi.<br>6. To study fungal identification using morphological characteristics and identification keys.<br>7. To study the effect of temperature, pH and nutrients on fungal growth.<br>8. To study industrial applications of fungi, including fermentation and production of enzymes, organic acids and antibiotics.<br>9. To study edible and medicinal fungi and their cultivation techniques.<br>10. To study fungal plant pathogens and symptoms of important fungal diseases.<br>11. To study biological control using beneficial fungi such as Trichoderma.<br>12. To study mycoremediation and biodegradation of organic wastes by fungi. | |

| | | |
|---|---|---|
| IV | **PRACTICALS: Plant Genomics**<br>1. To isolate genomic DNA from plant material using a suitable method.<br>2. To assess the quality and quantity of isolated DNA using spectrophotometry and/or agarose gel electrophoresis.<br>3. To study agarose gel electrophoresis for separation and visualization of DNA.<br>4. To perform PCR amplification of a selected plant DNA sequence.<br>5. To study PCR products by agarose gel electrophoresis.<br>6. To study DNA barcoding of plants using suitable barcode regions such as rbcL and matK.<br>7. To perform restriction digestion of DNA and analyse the resulting fragments.<br>8. To study DNA sequence retrieval and analysis using NCBI databases.<br>9. To perform BLAST analysis for identification and comparison of plant DNA sequences.<br>10. To perform multiple sequence alignment of selected plant sequences.<br>11. To construct and interpret a phylogenetic tree using molecular sequence data.<br>12. To study basic genome annotation and identification of genes/functional sequences using bioinformatics tools. | |